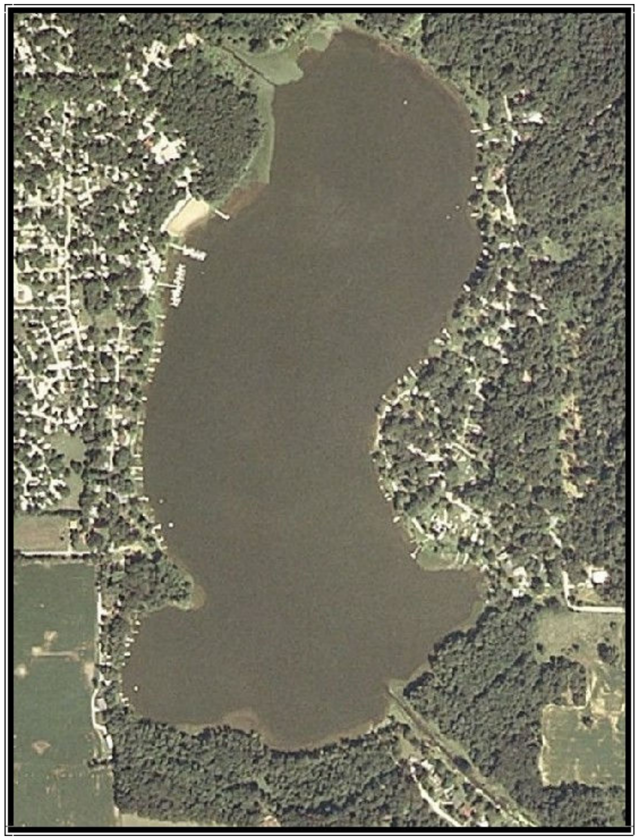


Ridinger Lake
Aquatic Vegetation Management Plan-
2007-Draft
2008-2012

December 3, 2007

Prepared for:
Tippecanoe Environmental Lake & Watershed Foundation
PO Box 55
North Webster, IN 46555

Prepared by:
Aquatic Control, Inc.
PO Box 100
Seymour, Indiana 47274

Executive Summary

Aquatic Control was contracted by the Tippecanoe Environmental Lake and Watershed Foundation (TELWF) to complete aquatic vegetation sampling in order to create a lakewide, long-term integrated aquatic vegetation management plan for Ridinger Lake. Ridinger Lake is a 135 acre natural lake located 5 miles south of North Webster in Kosciusko County, Indiana. This plan was created in order to more effectively document and control nuisance aquatic vegetation within the lake.

Aquatic vegetation is an important component of Indiana Lakes. Aquatic vegetation provides fish habitat, food for wildlife, prevents erosion, and can improve overall water quality. However, as a result of many factors, this vegetation can develop to a nuisance level. Nuisance aquatic vegetation, as used in this paper, describes plant growth that negatively impacts the present uses of the lake including fishing, boating, swimming, aesthetic, and lakefront property values. The primary nuisance species within the Ridinger Lake is the invasive exotic plant Eurasian watermilfoil (*Myriophyllum spicatum*). The negative impact of this species on native aquatic vegetation, fish populations, water quality, and other factors is well documented and will be discussed in further detail. Common coontail (*Ceratophylum demersum*) is a native species that can also create problems in high-use areas of Ridinger Lake. The invasive exotic species curlyleaf pondweed (*Potamogeton crispus*) was present at low levels.

In 2007 the Lake and River Enhancement (LARE) fund along with TELWF funded plant sampling and treatment of milfoil in Ridinger Lake. Sampling was completed on May 30 and July 24. The spring sampling consisted of an Invasive Mapping Survey, which located milfoil areas prior to treatment, and a Tier II survey which was used to quantify the submersed plant population. Treatment was completed on June 12 with 2,4-D granular herbicide. Over 14 acres of mifoil was mapped, but funds were only available for treatment of 10.4 acres of milfoil. The treatment appeared to be effective as no milfoil was sampled in the summer survey.

The primary recommendation for plant control within the Ridinger Lake involves the continued use of systemic herbicides to selectively control Eurasian watermilfoil throughout the lake. This type of treatment should preserve and enhance the population of native vegetation. The goal of this type of treatment is to eliminate milfoil from Ridinger Lake. This may be a difficult goal to achieve due to the abundance of this species in other lakes connected to Ridinger Lake and milfoil's ability to be easily transported from lake to lake. It is estimated that a maximum of 14 acres of milfoil may require treatment next season.

Vegetation surveys will be an important part of management in Ridinger Lake. A spring Invasive Mapping Survey should be completed in mid May in order to locate areas of milfoil to be treated. A summer Tier II survey should be completed in late July or August in order to document changes in submersed vegetation and aid in planning for the following season.

Control of milfoil may help enhance native vegetation within the lake by reducing competition, but poor water quality is likely the primary factor limiting native diversity. Native vegetation is beneficial to the overall health of the Ridinger Lake ecosystem, and invasive vegetation controls should focus only on the use of highly selective controls in order to reduce damage. Control of the invasive species should allow the native plant community to spread. Native vegetation would also be enhanced if lake users and property owners followed the recommendations laid out in the 2004 Diagnostic Study.

The following is a list of actions that should be initiated in order to enhance native vegetation diversity, control invasive species, and reduce nuisance conditions caused by aquatic vegetation in high-use areas:

1. Continue treatment of Eurasian watermilfoil in Ridinger Lake with 2,4-D herbicide. Treatment should take place in the spring of 2008 following sampling that will determine actual treatment areas. Treatment may be needed the following seasons and should be included in the long-term budget.
2. Monitor plant community with plant surveys for next five years in order to assess the effectiveness of controls and response of native plant community. Plant surveys will also be invaluable to quickly detect and control potential reinfestation of Eurasian watermilfoil. Surveys should consist of a spring invasive mapping survey and a summer Tier II survey. These surveys should be continued through 2012.
3. Post signs at access sites warning boaters of the potential for invasive plant species introductions from boat trailers. Signs should implore boaters to clean trailers, props, and boats of all vegetation fragments when entering and leaving Ridinger Lake. Information concerning the potential spread of Eurasian watermilfoil and hydrilla should be distributed to all Association members and lake users.
4. Take steps to improve water quality in Ridinger Lake. These potential actions are outlined in the 2004 Diagnostic Study. The Ridinger Lake Property Owners Association along with TELWF should work with IDNR on potential ways of funding these actions. These actions should have positive effects on the native plant community.
5. Remove purple loosestrife from individuals' property and pursue funding source to biological controls.
6. Maintain dock areas with physical plant removal when possible or by contracting professional applicators. Treatments should not exceed 100 feet from shoreline for submersed vegetation and treatment of rooted floating vegetation should be limited to boating lanes.
7. Monitor curlyleaf pondweed population.

Acknowledgements

Funding for the vegetation sampling and preparation of an aquatic vegetation management plan was provided by the Tippecanoe Environmental Lake and Watershed Foundation and the Indiana Department of Natural Resources Lake and River Enhancement Program. Aquatic Control, Inc. completed the fieldwork, data processing, and map generation. Special thanks are due to Holly LaSalle and Lyn Crighton from TELWF and Jill Jordan from the Ridinger Lake Homeowners Association for their help in initiating and completing this project. Special thanks are given to Bob Robertson, Fisheries Biologists for the Indiana Department of Natural Resources-Division of Fish and Wildlife, for his assistance and review of this plan. Special thanks are also given to Gwen White and Angela Studevant, Aquatic Biologist from the Lake and River Enhancement Program (LARE) for their review and assistance on this plan. Author of this report is Nathan Long of Aquatic Control. The author would like to acknowledge the valuable input from Brian Isaacs, Brendan Hastie, Joey Leach, and Barbie Huber of Aquatic Control for their field assistance, map generation, review, and editing of this report.

TABLE OF CONTENTS

SECTION	PAGE
Executive Summary	i
Acknowledgements	iii
Table of Contents	iv
List of Figures	v
List of Tables	vi
1.0 Introduction	1
2.0 Watershed and Lake Characteristics	1
3.0 Present Water Body Uses	3
4.0 Fisheries	4
5.0 Problem Statement	5
6.0 Aquatic Vegetation Management Goals	7
7.0 Past Management History	7
8.0 Aquatic Plant Community Characterization	9
8.1 Methods	10
8.1.1 Invasive Mapping	10
8.1.2 Tier II	11
8.2 Results	12
8.2.1 Spring Survey	12
8.2.2 Summer Survey	20
8.3 Discussion	25
9.0 Aquatic Vegetation Management Alternatives	25
9.1 No Action	26
9.2 Protection of Beneficial Vegetation	26
9.3 Environmental Manipulation	27
9.3.1 Water Level Manipulation	27
9.3.2 Nutrient Reduction	27
9.4 Mechanical Controls	27
9.4.1 Harvesting, Cutting	27
9.5 Manual Controls	28
9.6 Biological Controls	29
9.6.1 Grass Carp	29
9.6.2 Milfoil Weevil	29
9.6.3 Purple Loosestrife Insects	30
9.7 Chemical Controls	30
10.0 Public Involvement	32
11.0 Public Education	35
12.0 Integrated Treatment Action Strategy	35
13.0 Project Budget	42
14.0 Monitoring and Plan Updates	42
15.0 References Cited	43
16.0 Appendices	45
16.1 Data sheets	45
16.2 Vegetation control permit	47
16.4 Public input questionnaire	50

List of Figures

Figure 1. Ridinger Lake bathymetric map....2
Figure 2. Dissolved oxygen/temperature profile....3
Figure 3. Lake usage map....4
Figure 4. Illustration of Eurasian watermilfoil....6
Figure 5. Illustration of curlyleaf pondweed....7
Figure 6. Milfoil treatment areas, June 12, 2007....8
Figure 7. Sampling Rake....11
Figure 8. Eurasian watermilfiol beds, May 30, 2007....13
Figure 9. Curlyleaf pondweed beds, May 30, 2007....14
Figure 10. Ridinger Lake, coontail distribution and abundance, May 30, 2007....16
Figure 11. Ridinger Lake, Eurasian watermilfoil distribution and abundance, May 30, 2007....17
Figure 12. Ridinger Lake, slender naiad distribution and abundance, May 30, 2007....18
Figure 13. Ridinger Lake, curlyleaf pondweed distribution and abundance, May 30, 2007....19
Figure 14. Ridinger Lake, slender naiad distribution and abundance, July 24, 2007....22
Figure 15. Ridinger Lake, common coontail distribution and abundance, July 24, 2007....23
Figure 16. Ridinger Lake, curlyleaf pondweed distribution and abundance, July 24, 2007....24
Figure 17. Picture of harvester sitting in middle of milfoil bed....28
Figure 18. Crooked Lake, emergent plant community along developed shoreline....37
Figure 19. Picture of purple loosestrife mixed with other emergent plants....38
Figure 20. Illustration of hydrilla compared to native elodea. 40

List of Tables

Table 1. Morphological characteristics of Ridinger Lake 1
Table 2. Scientific and Common Names of Species Collected in Ridinger Lake 10
Table 3. Occurrence and abundance of submersed aquatic plants in Ridinger Lake, May 30, 2007 15
Table 4. Occurrence and abundance of submersed aquatic plants in Ridinger Lake, July 24, 2007 20
Table 5. Ridinger Lake, Lake User Survey, September 12, 2007 34

Table 6. Budget estimate for action plan 42

1.0 INTRODUCTION

Aquatic Control was contracted by the Tippecanoe Environmental Lake and Watershed Foundation (TELWF) to complete aquatic vegetation sampling in order to create a lakewide, long-term integrated aquatic vegetation management plan for Ridinger Lake. The study area includes Ridinger Lake, which is located 9 miles east of Warsaw and 5 miles south of North Webster in Kosciusko County, Indiana. This plan was created in order to more accurately document the aquatic vegetation community and create a feasible plan for managing nuisance vegetation within Ridinger Lake. The plan is also a prerequisite to eligibility for the Lake and River Enhancement (LARE) program funding to control invasive exotic species. Two aquatic vegetation surveys were completed in 2007 in order to document the plant community. The surveys will provide valuable information that will allow for scientifically based recommendations for aquatic plant management. In addition, LARE funded treatment on 10.4 acres of milfoil this season.

The primary nuisance plant species in Ridinger Lake is the exotic species Eurasian watermilfoil. The invasive exotic species curlyleaf pondweed was also detected, but at relatively low levels. Common coontail, a native submersed species, is also present in the lake and can create nuisance conditions in high-use areas. It is important to initiate management of these species in order to reduce nuisance conditions and stop their spread. In order to successfully manage aquatic vegetation on a public body of water concerns of fishermen, lot owners, biologists, and the general public will have to be addressed. The purpose of this plan is to provide scientific based plant management recommendations that will balance the concerns of these interest groups while effectively relieving Ridinger Lake of nuisance aquatic plant growth.

2.0 WATERSHED AND WATERBODY CHARACTERISTICS (Summarized from JFNew, 2004)

The Ridinger Lake watershed covers over 22,100 acres. Three major lakes, Ridinger Lake, Robinson Lake, and Troy Cedar Lake, as well as several smaller lakes, lie within the watershed. Agricultural land uses occupy over 80% of the watershed. Rindinger Lake is approximately 135 acres in size and has of volume of approximately 2,572 acre-feet (Table 1.) Ridinger Lake is fairly shallow with approximately 67% of the lake's surface area covering water that is less than 30 feet (Figure 1).

Table 1. Morphological characteristics of Ridinger Lake (JFNew, 2004).

Ridinger Lake	
Surface Area	135 acres
Volume	2,572 acre-feet
Maximum Depth	42 feet
Mean Depth	19 feet
Shoreline Length	12,645 feet
Shoreline Development Ratio	1.5:1

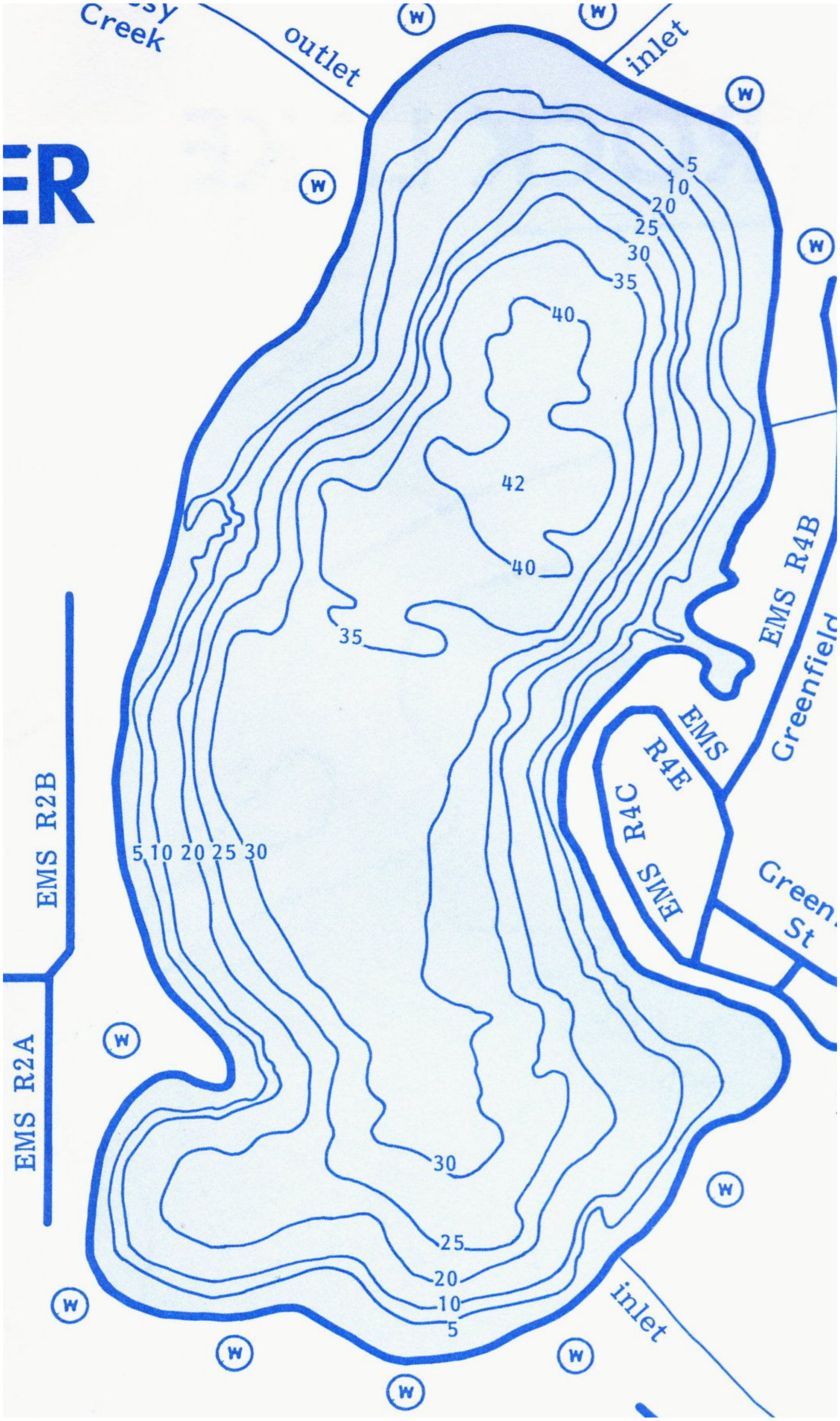


Figure 1. Ridinger Lake Bathymetric Map (Bright Spot Maps, 1999)

Ridinger Lake is a productive lake and is classified as hypereutrophic. The nutrient rich waters of the lake often lead to algae blooms and decreased clarity. Historical Secchi disk transparency depths typically ranged from 2.0-4.0 feet. The nutrient rich waters of Ridinger Lake combined with a relatively narrow area of shallow water, limits aquatic vegetation to a relatively narrow band around the lake (JFNew, 2004). A dissolved oxygen/temperature profile was completed on May 30, 2007. Dissolved oxygen levels above 5.0 mg/l were only present to a depth of 9.0 feet (Figure 2). High biological oxygen demand is a symptom of hypereutrophic lakes.

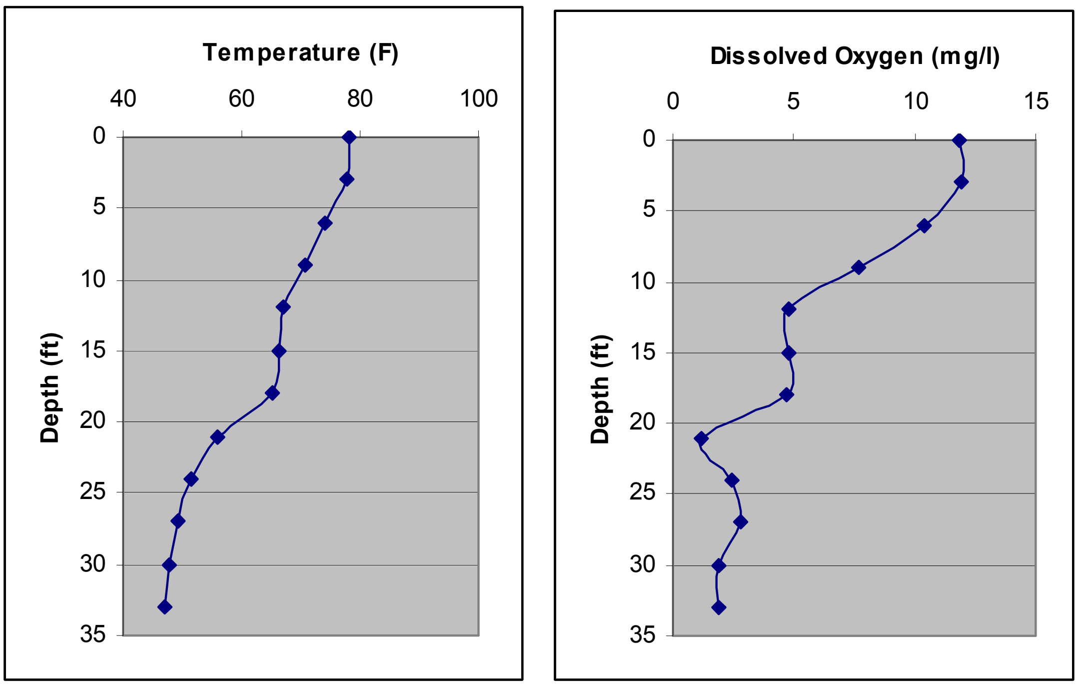


Figure 2. Ridinger Lake, dissolved oxygen/temperature profiles, May 30, 2007.

3.0 PRESENT WATER BODY USES

Ridinger Lake's shoreline is moderately developed compared to other northern Indiana Lakes. Jellystone Park, a large campground with a maximum capacity of 1200 campsites, is located along the western shoreline of the lake. This park also maintains a beach, boat rental, and private boat ramp along the western shore (Figure 3). In addition to the campground, approximately 120 homes ring the shoreline of the lake. Wetland areas are located in the southwest, southeast, and northwest corners of the lake (JFNew, 2004). A lake use survey distributed at the public meeting indicated that swimming, boating, and fishing are all popular activities on the lake.

Figure 3. Ridinger Lake Usage Map

4.0 FISHERIES (Summarized from JFNew, 2004)

The Indiana Department of Natural Resources (IDNR) conducted its first fishery survey on Ridinger Lake in 1978. In 1981, a major fish kill took place on Ridinger Lake following a large rain event. IDNR conducted follow up studies in 1981, 1982, and 1983 to determine the kill's impact on the fishery. The two most recent surveys occurred in 1995 and 2003 to assess the long-term status of Ridinger Lake's fish community.

Ridinger Lake has a diverse fish community with IDNR fisheries biologists collecting 30 species representing 11 families over the course of six surveys. In 1978, 24 species were collected. Following the fish kill in 1981, species diversity plummeted to 13 species. Bluegill composition declined from nearly 45% to approximately 4%, while crappie populations declined from 10% to near 0%. Gizzard shad numbers rose following the fish kill, replacing game fish as the most dominant component of the fishery.

By 1982, the fish community began to show signs of recovery from the fish kill. By 2003, the bluegill percent community composition has surpassed the pre-kill levels in 1978. Gizzard shad numbers also continued to rise, although their percent contribution declined. Largemouth bass were not significantly impacted by the fish kill. Above average catch and growth rates suggest the bass population is in good condition.

Over the past several years Ridinger Lake has seen a shift in fish biomass. Prior to the 1981 fish kill, gizzard shad, carp, and sucker accounted for 24.6% of the total catch weight. These species accounted for nearly 54% of the catch weight in 1982 and 56% in 1995. There was a slight decline to 52.9% in 2003. IDNR suggested that the selective stocking of other predatory fish species such as musky, pike, or walleye could be utilized to convert more of the lake's productivity back to game fish species. However, stocking efforts are only recommend once public access to the lake improves (Pearson, 1995 and 2003 cited in JFNew, 2004). .

4.1 Aquatic Vegetation and Fish Management

Aquatic vegetation is an important component in fisheries management. Aquatic vegetation provides cover for adult and juvenile fish, supports aquatic invertebrates that are eaten by fish, and shelters small fish from predators. Studies have shown that dense vegetation, especially Eurasian watermilfoil, can have negative effects of fish growth. Dr. Mike Maceina of Auburn University found that dense stands of Eurasian watermilfoil on Lake Guntersville proved to be detrimental to bass reproduction due to the survival of too many small bass. This led to below normal growth rates for largemouth bass and lower survival to age 1. Maceina found higher age 1 bass density in areas that contained no plants verses dense Eurasian watermilfoil stands (Maceina, 2001). Bluegill growth rates can also be affected by dense stands of Eurasian watermilfoil. It is well known by fisheries biologists that overabundant dense plant cover gives bluegill an increased ability to avoid predation and increases the survival of small young fish, which can lead to stunted growth. These problems will likely not occur on Ridinger Lake due to the limited area that can grow aquatic vegetation. Due to poor water clarity, Ridinger Lake's fish population may be negatively impacted by the lack of vegetation and the abundance of planktonic algae.

5.0 PROBLEM STATEMENT

As previously mentioned, aquatic vegetation is an important component of lakes in Indiana. However, as a result of many factors, this vegetation can develop to a nuisance level. Nuisance aquatic vegetation, as used in this paper, describes plant growth that negatively impacts the present uses of the lake including fishing, boating, swimming, aesthetic, and lakefront property values. The primary nuisance species within Ridinger Lake is the exotic species Eurasian watermilfoil. Curlyleaf pondweed is another submersed exotic species that is present at low levels in Ridinger Lake but has the potential to create nuisance conditions.

5.1 Problems Caused By Eurasian Watermilfoil

Eurasian watermilfoil is an exotic invasive species of submersed vegetation that was likely introduced into our region prior to the 1940's (Figure 4). This species commonly reaches nuisance levels in Indiana Lakes. Once established, growth and physiological characteristics of milfoil enable it to form a surface canopy and develop into immense stands of weedy vegetation, outcompeting most submersed species and displacing the native plant community. These surface mats can severely impair many of the functional aspects of waterbodies such as maintenance of water quality for wildlife habitat and public health, navigation, and recreation. Furthermore, a milfoil-dominated community can greatly reduce the biodiversity of an aquatic system and negatively impact fish populations (Getsinger et. al., 1997).

Figure 4. Illustration of Eurasian watermilfoil (Illustration provided by Applied Biochemist).

5.2 Problems Caused by Curlyleaf Pondweed

Curlyleaf pondweed is an invasive exotic submersed species that was likely introduced in the early 1900's. It is present in many Indiana natural lakes and manmade impoundments. Curlyleaf pondweed's wavy serrated leaves give it a rather unique appearance (Figure 5). Richardon's pondweed (*Potamogeton richarsonii*) is probably the only species that it can be easily confused with. Curlyleaf pondweed has the tendency to create dense surface mats in the spring and early summer. These mats can interfere with recreation and limit the growth of native species. Another problem associated with this species is caused by its summer die-off that tends to lead to algae blooms. The summer die-off also tends to lessen the impact of this species on lake recreation.

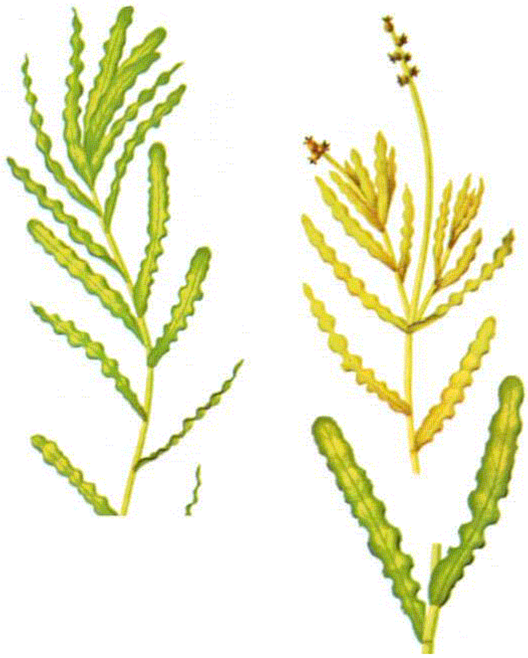


Figure 5. Illustration of curlyleaf pondweed (Illustration provided by Applied Biochemist).

6.0 VEGETATION MANAGEMENT GOALS

An effective aquatic vegetation management plan must include well-defined goals and objectives. Listed below are three goals formulated by LARE program staff and Division of Fish and Wildlife Biologists and approved by TELWF. The objectives and actions used to meet the objectives will be discussed in section 12.0. One must have a better understanding of the plant community before the objectives and actions can be discussed.

Vegetation Management Goals

1. Develop or maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality, and is resistant to minor habitat disturbances and invasive species
2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3. Provide reasonable public recreational access while minimizing the negative impacts on plant and fish and wildlife resources.

7.0 PLANT MANAGEMENT HISTORY

Small-scale shoreline herbicide treatments have been completed for several years on Ridinger Lake. These treatments were financed by individual homeowners and Jellystone Park. Aquatic Control Inc. treated 4-7 acres of shoreline vegetation from 1994-2001. Aquathol K, Reward, and copper sulfate were used to control Eurasian watermilfoil, curlyleaf pondweed, small pondweed, Chara, coontail, and filamentous algae. Treatment areas varied each year and were based on individual lot sign-up. Weed

Patrol and Aquatic Weed Control completed similar treatments in from 2001-2006. Aquatic Weed Control used contact herbicides to treat a 4.0 acre area around the Jellystone Park beach, ramp and boat rental. Reward, Aquathol, and copper sulfate were used in the application. The primary targets of the treatment were naiad, sago pondweed, and algae (Personal Communication w/ Jim Donahoe of Aquatic Weed Control).

In 2007, LARE and TELWF funded treatment of Eurasian watermilfoil on Ridinger Lake. A total of 14.1 acres was mapped out during a May survey, but funds were only available for treatment of 10.4 acres. Jellystone park had already contracted with another applicator to have their shoreline areas sprayed, so this area was not treated. On June 12, 2007, Aquatic Control treated 10.4 acres of milfoil with 2,4-D granular herbicide (trade name Navigate). Treatment was completed using boat mounted granular spreaders. A gps device containing a map of the treatment areas was used in order to insure accurate application (Figure 6).

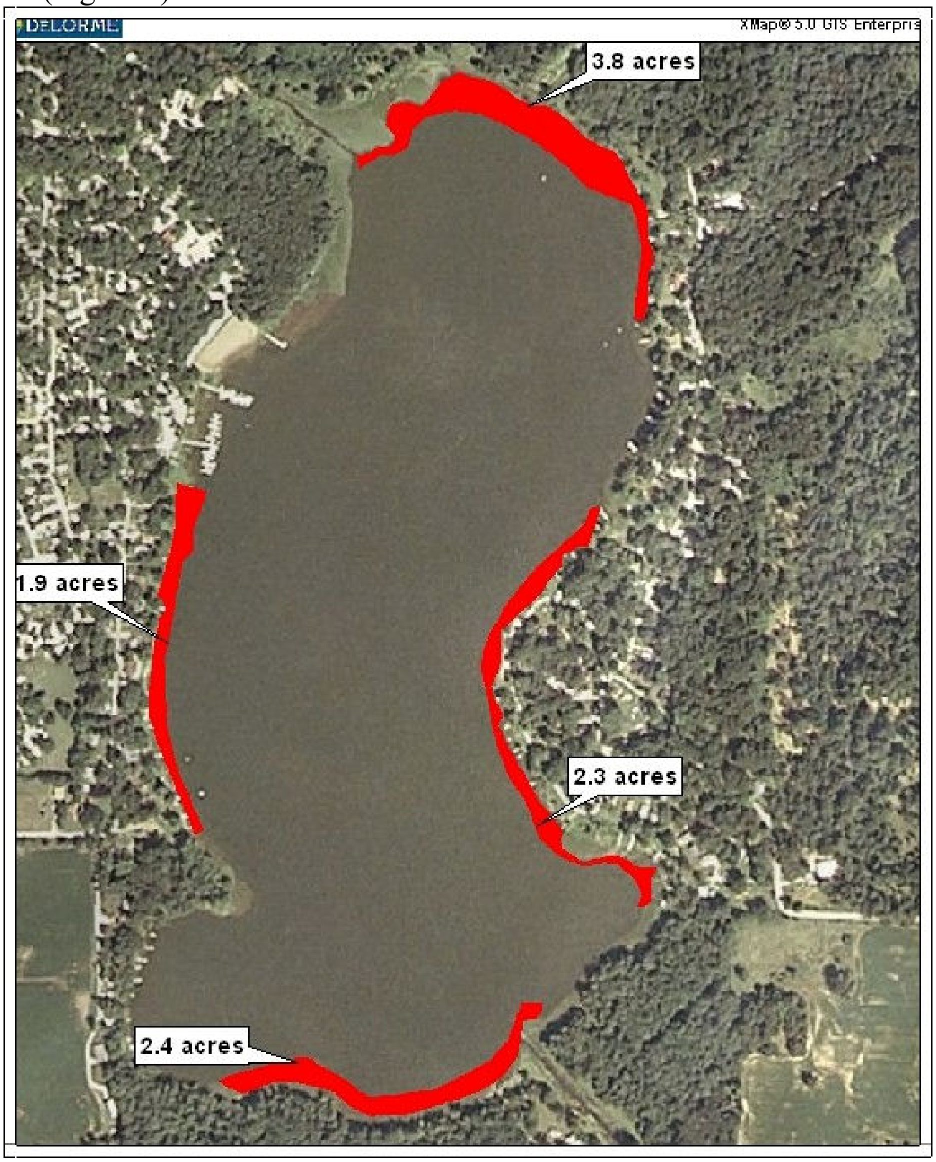


Figure 6. Ridinger Lake, milfoil treatment areas, June 12, 2007.

8.0 AQUATIC PLANT COMMUNITY CHARACTERIZATION

Aquatic vegetation sampling must be completed in order to create an effective aquatic vegetation management plan. Sampling provides valuable data that allows managers to accomplish several tasks: locate areas of nuisance and beneficial vegetation; monitor changes in density, abundance, and location of native and exotic species; monitor and react to changes in the overall plant community; monitor the effectiveness of management techniques; and compare the Ridinger Lake plant community to other populations.

IDNR has completed several plant surveys on Ridinger Lake as part of their fisheries work. The 1978 and 1995 surveys reported that pickerel weed, spatterdock, coontail, Eurasian watermilfoil, and filamentous algae were either common or abundant. In the 1990 International Science and Technology survey it was noted that Eurasian watermilfoil and spatterdock were the most common species in Ridinger Lake. With the exception of 2007, JFNew completed the most recent plant survey on Ridinger Lake as part of the 2004 Diagnostic Study. The Tier I sampling protocol was used in this survey. The survey found that plants were confined to depths less than 10 feet. Fourteen individual plant beds were distinguished around the shoreline. Thirty-six different species were observed during the survey with the majority of species being emergents with pickerel weed as the dominant emergent species. Common submersed species included Eurasian watermilfoil, coontail, and sago pondweed, while spatterdock dominated the rooted-floating stratum. JFNew noted that there was a general sparseness of vegetation within the plant beds and theorized that this was likely due to herbicide applications along the developed shoreline. The presence of purple loosestrife was also documented in Ridinger Lake during this survey (JFNew, 2004).

In 2007, Aquatic Control Inc. completed two surveys on Ridinger Lake. These surveys were completed according to the LARE surveying protocol that is described below. An Invasive Species Mapping and Tier II survey was completed on May 30. On July 24, a second Tier II survey was conducted. A table outlining the scientific and common names of the species sampled in 2007 from Ridinger Lake is listed on the following page.

Table 2. Scientific and Common Names of Species Sampled in 2007 from Ridinger Lake.

Scientific Name	Common Name
Cephalanthus occidentalis	button bush
Ceratophyllum demersum	common coontail
Chara spp.	Chara
Decodon verticillatus	swamp loosestrife
Iris versicolor	blue flag iris
Lemna minor	duckweed
Lemna triscula	star duckweed
Myriophyllum spicatum	Eurasian watermilfoil
Najas flexilis	slender naiad
Nuphar variegetum	spatterdock
Nymphaea tuberosa	white water lily
Peltandra virginica	arrow arum
Pontederia cordata	Pickerel Weed
Potamogeton crispus	curlyleaf pondweed
Potamogeton foliosus	leafy pondweed
Potamogeton nodosus	American pondweed
Potamogeton pectinatus	sago pondweed
Typha latifolia	common cattail
Wolffia spp.	watermeal
Zosterella dubia	water stargrass

8.1 Methods

8.1.1 Invasive Mapping Survey

The purpose of the invasive mapping survey is to locate and record areas of invasive species. The maps created from this survey can then be used by the plant manager in order to effectively control the areas of invasive species. At this time there is no standard IDNR protocol for the invasive mapping survey. Despite the lack of protocol, most plant managers have developed accurate techniques for this type of survey since this technique is needed in order to make accurate treatments.

Mapping is completed by using a motorized boat. Prior to mapping, a Secchi disk reading is taken and the maximum depth of vegetation growth is determined. This type of survey requires one driver and at least one surveyor. The surveyor positions themselves on the bow of the boat with a map and gps device. The surveyor motions the driver navigational directions and the boat is driven in a zigzag pattern around the littoral zone of the lake. Once an invasive species is observed the surveyor records the position on the device. The area where the invasive species is observed is then surveyed in a tighter zigzag fashion until the edges of the invasive plant bed can be determined. Waypoints are taken around the edge of the invasive beds and notes are recorded on the map concerning density of vegetation within the bed (if plants are not visible within littoral areas then rake tosses should be used in place of visual observation). This information is taken back to the office and downloaded into a mapping program that contains an accurate aerial shot of the lake. The areas where invasive species were recorded are then mapped and measured using the mapping program. This survey method serves to meet the following objectives:

1. to provide a distribution map of invasive species within a waterbody
2. to document gross changes in the extent of invasive species within a waterbody

8.1.2 Tier II Methods

The Tier II survey helps meet the following objectives:

1. to document the distribution and abundance of submersed and floating-leaved aquatic vegetation
2. to compare present distribution and abundance with past distribution and abundance within select areas

The number and depth of sampling sites are selected based upon lake size and classification. Once a site was reached the boat was slowed to a stop and the coordinates were recorded on a hand-held GPS unit and later downloaded into a mapping program. A depth measurement was taken by dropping a two-headed standard sampling rake that was attached to a rope marked off in 1-foot increments (Figure 7). An additional ten feet of rope was released and the boat was reversed at minimum operating speed for a distance of ten feet. Once the rake is retrieved the overall plant abundance on the rake is scored with either a 0 (no plants retrieved), 1 (1-20% of rake teeth filled), 3 (21-99% of rake teeth filled), or 5 (100% of rake teeth filled) and then individual species are placed back on the rake and scored separately.

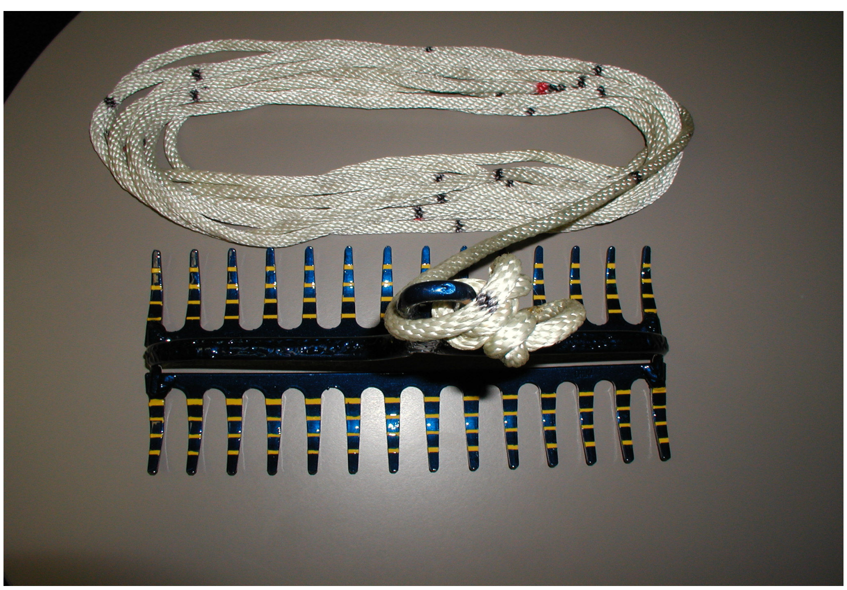


Figure 7. Sampling Rake

The data is used to calculate different lake characteristics and community and species metrics. The different characteristics and metrics calculated from the Tier II method are defined below:

Littoral depth: Maximum depth that aquatic vegetation is present.
Total sites: Total number of sites sampled.
Littoral sites: Number of sites within the littoral depth.
Secchi depth: Measurement of the transparency of water.
Species richness: count of all submersed plant species collected.
Native species richness: count of all native submersed plant species collected.
Maximum number of species per site: highest number of species collected at any site.
Mean number of species per site: The average number of all species collected per littoral site.
Mean number of native species per site: The average number of native species per site.
Species diversity index: This is a modified Simpson's diversity index which is a measure that provides a means of comparing plant community structure and stability over time.
Frequency of occurrence: Measurement of the proportion of sites where each species is present.
Relative frequency of occurrence: Measures how the plants occur throughout the lake in relation to each other.
Dominance index: Combines the frequency of occurrence and relative density into a dominance value that characterizes how dominant a species is within the macrophyte community (IDNR, 2007).

8.2 Results

8.2.1 2007 Spring Survey

On May 30, 2007, Aquatic Control completed Invasive Mapping and Tier II surveys. A Secchi measurement was taken and found to be 4.0 feet. Plants were growing to a maximum depth of 7.0 feet.

Spring Invasive Mapping Survey

The mapping survey located 14.1 acres of Eurasian watermilfoil in the lake (Figure 8). Areas of dense milfoil (>50% abundance) encompassed a 6.4 acre area. The dense beds were located in northern and southern sections of the lake. Milfoil appears to be limited to the near-shore areas.

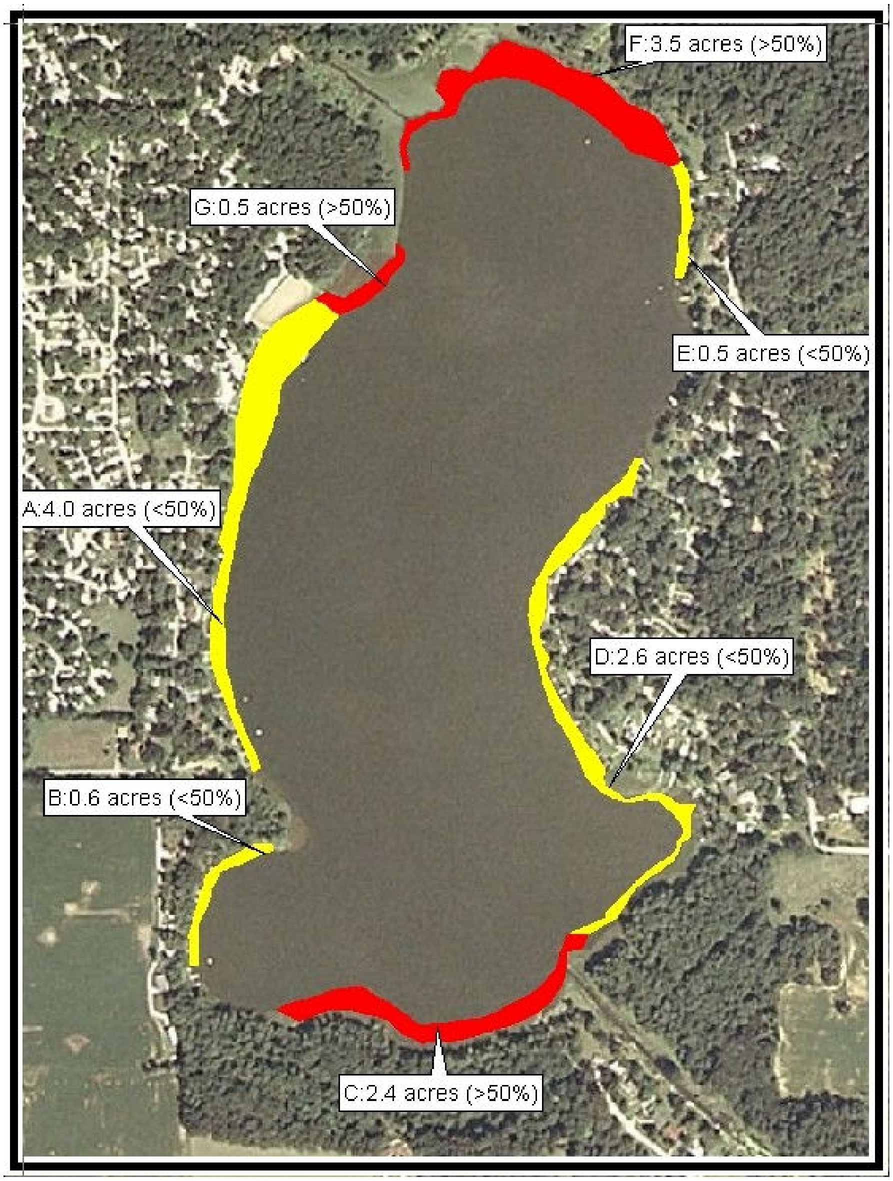


Figure 8. Ridinger Lake, Eurasian watermilfoil beds, May 30, 2007

Curlyleaf pondweed was also detected in Ridinger Lake, but encompassed a much smaller area and occurred at lower densities than milfoil. A total of 2.5 acres of curlyleaf was mapped in two beds. Both beds were located along the western shoreline and had less than 50% coverage of curlyleaf pondweed (Figure 9).

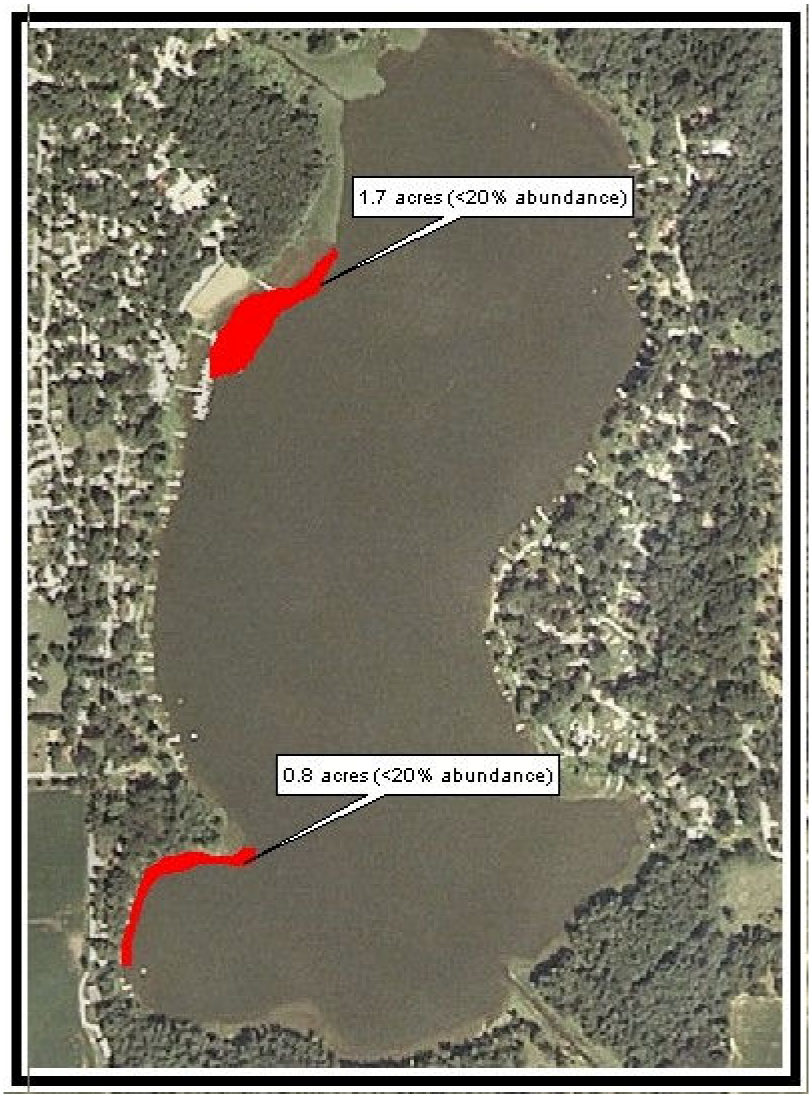


Figure 9. Ridinger Lake, curlyleaf pondweed areas, May 30, 2007.

Spring Tier II survey

Tier II sampling took place immediately following the invasive species mapping. Plants were present to a maximum depth of 7.0 feet. Fifty sites were selected within the littoral zone. The number and depth of the sites was determined prior to the survey and based on lake size and trophic status. Forty sites were sampled from 0-5 feet and ten sites were sampled from 5-10 feet (due to plants only being present to a depth of 7.0 feet, future sampling should be conducted no deeper than 7.0 feet). Results of the sampling are listed in Table 3. Plants were collected at 39 of the 50 sites. A total of 8 species were collected of which 6 of the species were natives. The maximum number of species collected at a site was 5 and the mean species collected per site was 2.00 while the mean number of native species collected per site was 1.54. The species diversity index was 0.79 and the native species diversity index was 0.71.

Table 3. Occurrence and abundance of submersed aquatic plants in Ridinger Lake, May 30, 2007.

Occurrence and abundance of submersed aquatic plants in Ridinger Lake					
County:	kos	Sites with plants:	41	Mean species/site:	2.00
Date:	5.30.07	Sites with native plants:	39	Standard error (ms/s):	0.1873554
Secchi (ft):	4'	Number of species:	8	Mean native species/site:	1.54
Maximum plant depth (ft):	7.0'	Number of native species:	6	Standard error (mns/s):	0.1570389
Trophic status	Hypereutroph	Maximum species/site:	5	Species diversity:	0.79
Total sites:	50			Native species diversity:	0.71

All depths (0 to 10 ft)	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
common coontail	64.0	36.0	24.0	24.0	16.0	28.8
Eurasian watermilfoil	46.0	54.0	14.0	20.0	12.0	12.4
slender naiad	36.0	64.0	12.0	16.0	8.0	8.8
sago pondweed	22.0	78.0	4.0	12.0	6.0	6.8
Chara	16.0	84.0	4.0	4.0	8.0	4.8
curlyleaf pondweed	8.0	92.0	2.0	4.0	2.0	2.4
leafy pondweed	6.0	94.0	2.0	2.0	2.0	1.2
water stargrass	2.0	98.0	0.0	0.0	2.0	0.4

All depths (0 to 5 ft)	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
common coontail	77.5	22.5	27.5	30.0	20.0	35.5
Eurasian watermilfoil	52.5	47.5	15.0	22.5	15.0	13.5
slender naiad	42.5	57.5	12.5	20.0	10.0	10.5
sago pondweed	27.5	72.5	5.0	15.0	7.5	8.5
Chara	20.0	80.0	5.0	5.0	10.0	6.0
curlyleaf pondweed	10.0	90.0	2.5	5.0	2.5	3.0
leafy pondweed	7.5	92.5	2.5	2.5	2.5	1.5
water stargrass	2.5	97.5	0.0	0.0	2.5	0.5

All depths (5 to 10 ft)	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	
Eurasian watermilfoil	20.0	80.0	10.0	10.0	0.0	8.0
common coontail	10.0	90.0	10.0	0.0	0.0	2.0
slender naiad	10.0	90.0	10.0	0.0	0.0	2.0

Other Species Observed: Spatterdock, blueflag iris, pickeral weed, button bush, arrow arum, common cattail

Common coontail was the most frequently occurring (64.0%) and most dominant species (28.8). Coontail was most dominant in the 0-5 foot range. Location and density of coontail is illustrated in Figure 10 (in species location and density figures, plant location is illustrated by a color coded dot, the color of the dot represents the density of the species and sample sites without that species are illustrated by smaller white diamond). Eurasian watermilfoil was the second most frequently occurring species (46.0%) and also ranked second in dominance (13.5). Eurasian watermilfoil was the most frequently occurring and dominant species in the 5-10 foot depth range. Location and density of milfoil is illustrated in Figure 11. Slender naiad (Figure 12), sago pondweed, and Chara are all native species that were collected at more than 10% of sites. Curyleaf pondweed ranked sixth in frequency of occurrence (10%) and dominance (Figure 13). Leafy pondweed and water stargrass occurred at less than 10% of sites.

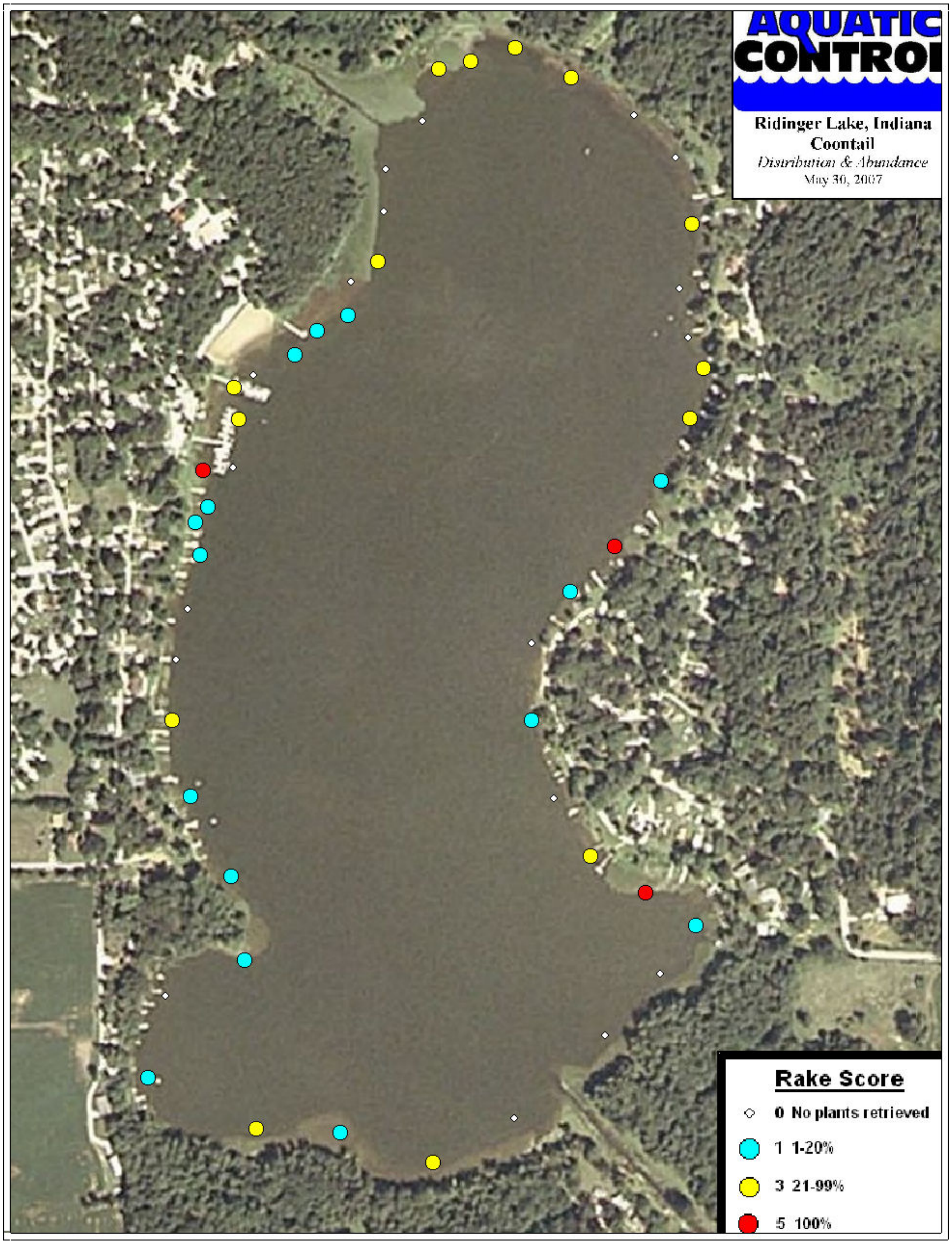


Figure 10. Ridinger Lake, common coontail distribution and abundance, May 30, 2007.

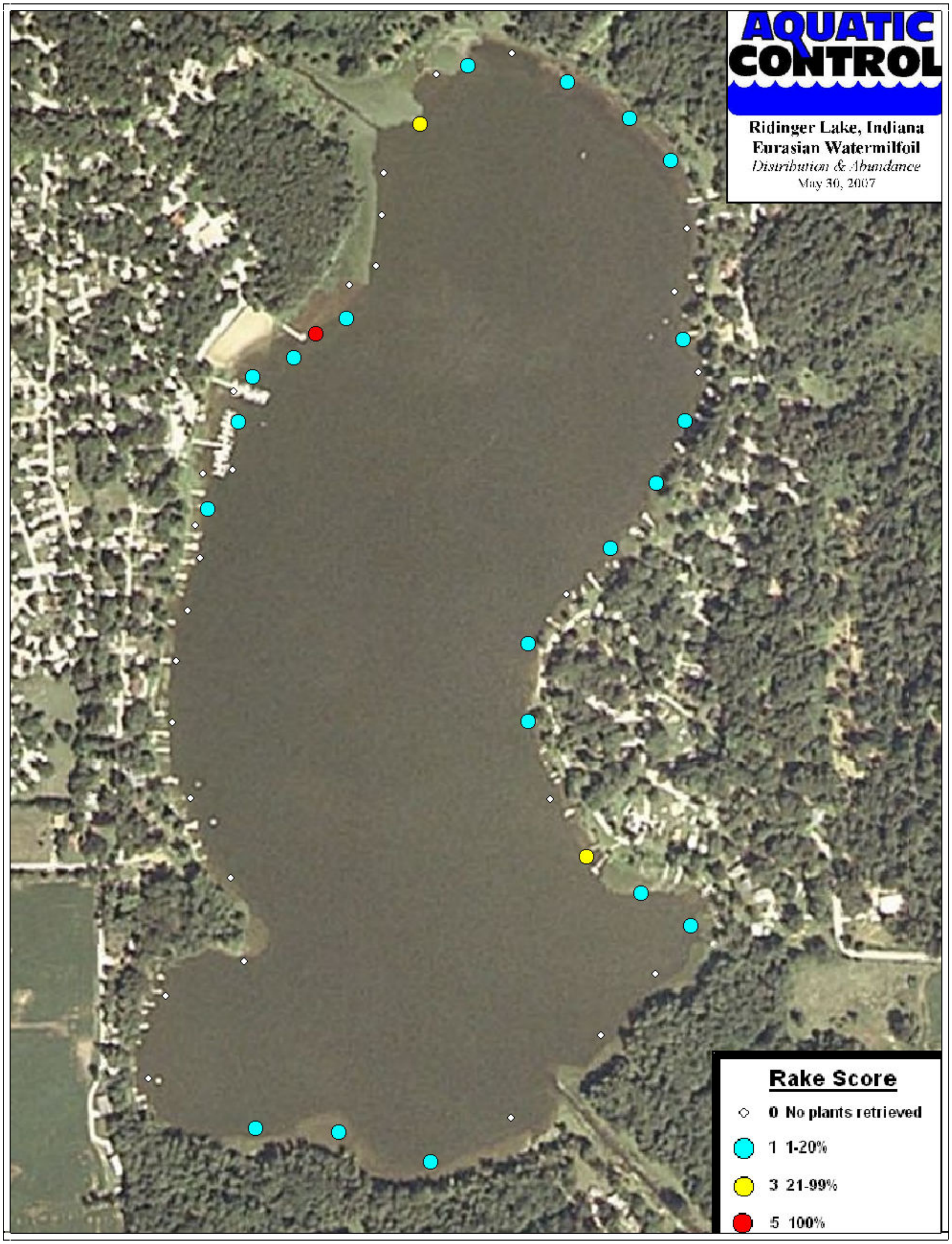


Figure 11. Ridinger Lake, Eurasian watermilfoil distribution and abundance, May 30, 2007.

Figure 12. Ridinger Lake, slender naiad distribution and abundance, May 30, 2007.

Figure 13. Ridinger Lake, curlyleaf pondweed distribution and abundance, May 30, 2007

8.2.2 2007 Summer Survey

Summer Tier I survey

A second round of Tier II sampling took place on July 24, 2007. A Secchi disk reading was taken prior to the survey and found to be 3.0 feet. Once again, plants were present to a maximum depth of 7.0 feet. The same fifty sites were sampled in the summer survey. Results of the sampling are listed in Table 4. Plants were collected at 24 of the 50 sites. A total of 7 species were collected of which 6 of the species were natives. The maximum number of species collected at a site was 3 and the mean species collected per site was 0.96. The species diversity index was 0.77 and the native species diversity index was 0.76.

Table 4. Occurrence and abundance of submersed aquatic plants in Ridinger Lake, July 24, 2007.

Occurrence and abundance of submersed aquatic plants in Ridinger Lake					
County:	Kosciusko	Sites with plants:	24	Mean species/site:	0.96
Date:	7.24.07	Sites with native plants:	24	Standard error (ms/s):	0.1589763
Secchi (ft):	3	Number of species:	7	Mean native species/site:	0.96
Maximum plant depth (ft):	7	Number of native species:	6	Standard error (mns/s):	0.1589763
Trophic status	hypereutroph	Maximum species/site:	3	Species diversity:	0.77
Total sites:	50			Native species diversity:	0.76

All depths (0 to 10 ft) Species	Frequency of Occurrence	Rake score frequency per species 0	1	3	5	Plant Dominance
slender naiad	28.0	72.0	6.0	4.0	14.0	19.2
common coontail	28.0	72.0	8.0	6.0	10.0	10.4
Chara	18.0	82.0	4.0	0.0	12.0	4.4
leafy pondweed	14.0	86.0	6.0	2.0	6.0	3.6
sago pondweed	4.0	96.0	0.0	4.0	0.0	1.6
American pondweed	2.0	98.0	0.0	0.0	2.0	0.4
curlyleaf pondweed	2.0	98.0	0.0	0.0	2.0	0.4

All depths (0 to 5 ft) Species	Frequency of Occurrence	Rake score frequency per species 0	1	3	5	Plant Dominance
common coontail	55.0	45.0	15.0	15.0	25.0	19.0
slender naiad	50.0	50.0	5.0	10.0	35.0	40.0
Chara	35.0	65.0	5.0	0.0	30.0	9.0
leafy pondweed	25.0	75.0	5.0	5.0	15.0	7.0
sago pondweed	10.0	90.0	0.0	10.0	0.0	4.0
American pondweed	5.0	95.0	0.0	0.0	5.0	1.0
curlyleaf pondweed	5.0	95.0	0.0	0.0	5.0	1.0

All depths (5 to 10 ft) Species	Frequency of Occurrence	Rake score frequency per species 0	1	3	5	Plant Dominance
slender naiad	14.3	85.7	7.1	0.0	0.0	5.7
common coontail	10.7	89.3	3.6	0.0	0.0	5.0
Chara	7.1	92.9	3.6	0.0	0.0	1.4
leafy pondweed	7.1	92.9	7.1	0.0	0.0	1.4

Other Species Observed: White water lily, spatterdock, arrow arum, pickeral weed, common cattail, swamp loosestrife

Common coontail and slender naiad were the most frequently occurring species (55%), but slender naiad had the highest dominance rating. Location and density of these species is illustrated in Figures 14 & 15. Chara and leafy pondweed both occurred at greater than 10% of sample sites. Sago pondweed was collected at only two sites while American pondweed was collected at a single site. Curlyleaf pondweed was the only exotic species collected and it was found at only a single site. Location of and density of curlyleaf pondweed is illustrated in Figure 16. Eurasian watermilfoil and water stargrass were collected in the spring survey, but not found in the summer survey. American pondweed was the only species collected in the summer survey that was not represented in the spring survey.

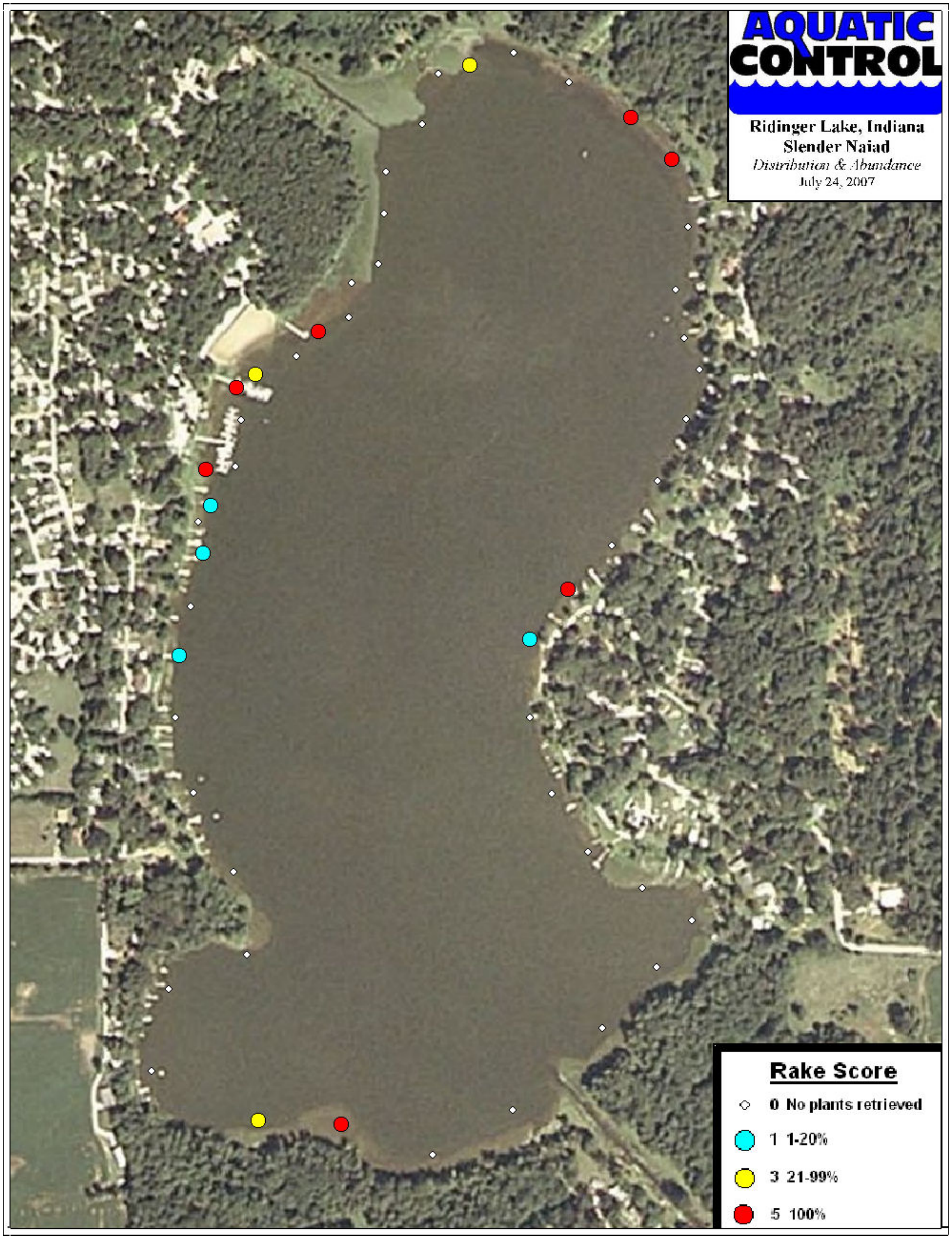


Figure 14. Ridinger Lake, slender naiad distribution and abundance, July 24, 2007.

Figure 15. Ridinger Lake, common coontail distribution and abundance, July 24, 2007.

Figure 16. Ridinger Lake, curlyleaf pondweed distribution and abundance, July 24, 2007.

8.3 Macrophyte Survey Discussion

The plant community of Ridinger Lake appears to be negatively impacted by poor water quality. The poor water quality leads to a reduction in light penetration thus limiting the depth to which vegetation can grow. In addition, it is believed that many submersed species are less tolerant to poor water quality thus limiting the diversity of vegetation in Ridinger Lake. Despite the poor water quality, Ridinger Lake does contain beneficial areas emergent and rooted floating vegetation that should be protected. Surveys completed this season also indicated the presence of several potentially beneficial submersed native species. Unfortunately, overall plant abundance and diversity appeared to have declined when comparing the spring surveys to the summer surveys. This was a surprising phenomenon, since native vegetation usually reaches its maximum abundance and diversity by late summer. The reason for the decline is not clear. One possibility could be vegetation controls completed on the lake, but the LARE sponsored treatment was completed using 2,4-D herbicide, which has no effect on the majority of the beneficial species, and contact treatments were limited to 4 acres of shoreline.

Eurasian watermilfoil was the primary nuisance exotic species in Ridinger Lake. The spring surveys indicated that this species was present in over 14 acres of the littoral zone and also ranked second in abundance behind coontail. However, milfoil was not collected in the summer survey. This may have been the result of treatments that specifically targeted Eurasian watermilfoil.

Curlyleaf pondweed was relatively sparse in the spring survey when one would expect it to be at its maximum abundance. The invasive capabilities of curlyleaf pondweed are not completely understood. In the right environment it can completely overrun littoral areas, while in the wrong environment it tends to remain at low levels. The exact environmental factors that affect its invasiveness are not completely understood, but it appears that Ridinger lake does not offer the right conditions for this plant to become a severe problem. However, it will be important to closely monitor this species in order to make sure this species remains at low levels.

Purple loosestrife was not detected in the 2007 surveys but its presence was noted in the 2003 JFNew Tier I survey (the 2007 survey focused primarily on submersed species, but plant samplers did make a visual observation of the emergent community and did not detect purple loosestrife). Steps should be taken to keep this species at a low level.

9.0 AQUATIC PLANT MANAGEMENT ALTERNATIVES

The abundance of Eurasian watermilfoil is the primary cause of concern when it comes to plant management. This species can create a variety of problems if left unchecked. Eurasian watermilfoil can negatively impact native species abundance, create nuisance conditions, and also negatively effect fish populations. Once established, growth and physiological characteristics of Eurasian watermilfoil enable it to form a surface canopy and develop into immense stands of weedy vegetation, out competing most submersed species and displacing the native plant community (Madsen et al., 1988). Many effective control techniques are available for targeting this species.

In order to develop a scientifically sound and effective action plan for control of nuisance vegetation, all aquatic management alternatives need to be considered. The alternatives that will be discussed include: no action; institutional; environmental manipulation; mechanical control; manual control; biological control; chemical control; and any combination of these methods.

A number of different techniques have been successfully used to control nuisance vegetation. These techniques vary in terms of their efficacy, rapidity, and selectivity, as well as the thoroughness and longevity of control they are capable of achieving. Each technique has advantages and disadvantages, depending on the circumstances. Selectivity is a particularly important characteristic of control techniques. Nearly all aquatic plant control techniques are at least somewhat selective, in that they affect some plant species more than others. Even techniques such as harvesting that have little selectivity within the areas to which they are applied can be used selectively, by choosing only certain areas in which to apply them. Selectivity can also occur after the fact, as when a technique controls all plants equally but some grow back more rapidly. One facet of selecting an appropriate aquatic plant control technique is matching the selectivity of the control technique with the goals of aquatic plant management. When controlling Eurasian watermilfoil, for example, it is typically desirable to use techniques that control Eurasian watermilfoil with minimal impact on most native species (Smith, 2002).

9.1 No Action

What if no aquatic plant management activity took place on the Ridinger Lake? Past management practices have included herbicide treatments of selected shoreline areas. These treatments were successful for short-term control of nuisance species. Steps should be taken that provide longer-term control of invasive species. If left unchecked, Eurasian watermilfoil would likely continue to spread and may increase in abundance and density. This increase may lead to a decrease in abundance of beneficial native species along with an increase in nuisance conditions.

9.2 Institutional-Protection of Beneficial Vegetation

Presence of beneficial vegetation can inhibit the growth of species which may be more prone to create nuisance conditions. For example, if a bed of mixed pondweeds is controlled, that area could more easily become infested by Eurasian watermilfoil. Most pondweeds don't reach the surface and if they do they typically do not develop the density of a milfoil bed. Dense milfoil beds are very difficult to boat across, difficult to fish, and provide poor habitat. On the other hand, pondweeds rarely reach the density of Eurasian watermilfoil and can provide excellent habitat for fish and aquatic invertebrates. Many associations attempt to control all vegetation. This can create a competitive advantage for aggressive species like Eurasian milfoil which can quickly colonize a controlled area. Protection of beneficial vegetation should be part of any vegetation management plan.

9.3 Environmental Manipulation

9.3.1 Water Level Manipulation

Water level manipulation refers to the raising of water levels to control aquatic vegetation by drowning or lowering to control aquatic vegetation by exposing them to freezing, drying or heat. Use of water level manipulation for aquatic plant management is limited to lake and reservoirs with adequate water control structures. Ridinger Lake does not have adequate water control structures, so this technique should not be considered.

9.3.2 Nutrient Reduction

Plant growth can be limited if at least one nutrient, which is critical for growth, is in short supply. Nitrogen, phosphorus or carbon are usually the nutrients limiting plant growth in lakes. Therefore, if at least one of these nutrients can be limited sufficiently so that plants do not grow to a nuisance level, this nutrient limitation can be used as a method of aquatic plant management. Generally, however, plants in northern Indiana can obtain the majority of necessary nutrients from the soil. Reduction of nutrients can actually aggravate an existing problem by increasing light penetration leading to an expansion in plant growth (Hoyer & Canfield, 1997). However, in certain situations, nutrient reduction can be effective at controlling overabundant floating vegetation or microscopic algae blooms.

9.4 Mechanical Control-Harvesting, Cutting, Dredging

Mechanical control includes cutting and/or harvesting of aquatic vegetation or dredging the bottom sediments to eliminate aquatic plant growth. The main advantage to mechanical control is the immediate removal of the plant growth from control areas and the removal of organic matter and nutrients.

One of the most common mechanical control techniques used on larger lakes in Indiana is mechanical harvesting. Mechanical harvesting uses machines which cut plant stems and, in most cases, pick up the cut fragments for disposal. This type of mechanical control has little selectivity. Where a mix of Eurasian watermilfoil and native species exists, harvesting favors the plant species that grow back most rapidly following harvesting. In most cases, Eurasian watermilfoil recovers from harvesting much more rapidly than native plants. Thus, repeated harvesting hastens the replacement of native species by Eurasian watermilfoil and often leads to dense monocultures of Eurasian watermilfoil in frequently harvested areas (Figure 17). Harvesting also stirs up bottom sediments thus reducing water clarity, kills fish and many invertebrates, and hastens the spread of Eurasian watermilfoil via fragmentation.

Figure 17. Picture of a harvester sitting in middle of milfoil bed.

Dredging of shallow areas may reduce nuisance conditions caused by vegetation in the short-term, but studies and personal experience have shown that Eurasian watermilfoil is often the first species to colonize these disturbed areas. Dredging is expensive, especially if a nearby disposal sight is not available. Careful consideration to secondary environmental effects must be considered and permits from regulatory agencies are usually necessary before conducting dredging operations. Dredging is usually short lived if not done deeper than the photic zone.

9.5 Manual Control-Hand Pulling, Cutting, Raking

Removal of small amounts of vegetation by hand, which interfere with beach areas or boat docks, may be the only vegetation control necessary in some areas. Of course, hand removal is labor intensive and must be conducted on a routine basis. The frequency and practicality of continued hand removal will depend on availability of labor, regrowth or reintroduction potential of the vegetation, and the level of control desired (Hoyer & Canfield, 1997). Residents of Ridinger Lake have the option to harvest areas of submersed vegetation in and around their docks or swimming areas. Residents should keep in mind that only a 625 square foot area can be harvested without obtaining a permit from IDNR.

9.6 Biological Controls
Biological controls reduce aquatic vegetation using other organisms that consume aquatic plants or cause them to become diseased. The main biological controls for nuisance vegetation used in Indiana are the grass carp, milfoil weevil, and a variety of insects which prey upon purple loosestrife. Any use of biological controls or stocking fish in public waters in Indiana requires a permit from the IDNR Division of Fish and Wildlife.

9.6.1 Grass Carp
The grass carp (*Ctenopharyngodon idella)* is an herbivorous fish imported from Asia. Triploid grass carp, the sterile genetic derivative of the diploid grass carp, are legal for use in Indiana, but are not permitted for stocking in any natural lakes in the state. Grass carp tend to produce all or nothing aquatic plant control. It is very difficult to achieve a stocking rate sufficient to selectively control nuisance species without eliminating all submersed vegetation. They are not particularly appropriate for Eurasian watermilfoil control because this species is low on their feeding preference list; thus, they eat most native plants before consuming Eurasian watermilfoil (Smith, 2002). Grass carp are also difficult to remove from a lake once they have been stocked. Due to the legal concerns and ineffectiveness of the grass carp to correct the problem, grass carp are not recommended for nuisance vegetation control in the Ridinger Lake.

9.6.2 Milfoil Weevil
The milfoil weevil, *Euhrychiopsis lecontei,* is a native North American insect that consumes Eurasian and Northern watermilfoil. The weevil was discovered following a natural decline of Eurasian watermilfoil in Brownington Pond, Vermont (Creed and Sheldon, 1993), and has apparently caused declines in several other water bodies. Weevil larvae burrow in the stem of Eurasian watermilfoil and consume the vascular tissue thus interrupting the flow of sugars and other materials between the upper and lower parts of the plant. Holes where the larvae burrow into and out of the stem allow disease organisms a foothold in the plants and allow gases to escape from the stem, causing the plants to lose buoyancy and sink (Creed et al. 1992).

Concerns about the use of the weevil as a biological control agent relate to whether introductions of the milfoil weevil will reliably produce reductions in Eurasian watermilfoil and whether the resulting reductions will be sufficient to satisfy users of the lake (Smith, 2002). Following our research, no conclusive data concerning the role of weevils in reducing Eurasian watermilfoil populations has been made available. In 2003, Scribailo and Alix conducted a weevil release study on three Indiana lakes and had no conclusive evidence supporting the use of weevils in reducing milfoil populations. Weevils may reduce milfoil populations in some lakes, but predicting which lakes and how much, if any, control will be achieved has not been documented (Scribailo & Alix, 2003).

9.6.3 Purple Loosestrife Insects (Summarized from JFNew & Associates, 2005)
Some control of purple loosestrife has been achieved through the use of several insects. A pilot project in Ontario, Canada reported a decrease in 95% of the purple loosestrife population from pretreatment population (Cornell Cooperative Extension, 1996 cited in JFNew, 2005). Four different insects were used to achieve this control. These insects have been identified as natural predators of purple loosestrife in its native habitat. Insect releases in Indiana to date have had mixed results. After six years, the loosestrife of Fish Lake in LaPorte County is showing signs of deterioration. Likewise, seven years after the release at Pleasant Lake in St. Joseph County, purple loosestrife populations appear to have declined around the boat ramp (IDNR, 2004 cited in JFNew, 2005). Biological control is not a quick solution; many estimates suggest that it may take 5-15 years to achieve a large impact on purple loosestrife populations.

9.7 Chemical Control
Chemical control uses chemical herbicides to reduce or eliminate aquatic plant growth. The main disadvantage to the use of chemicals is the publics concern over safety. Extensive testing is required of aquatic herbicides to ensure that the herbicides are low in toxicity to human and animal life and they are not overly persistent or bioaccumulated in fish or other organisms. It often takes several decades of testing by the Environmental Protection Agency (E.P.A.) before an herbicide is approved for aquatic use. After E.P.A approval and registration, the herbicide must go through the registration process in each state.

Another disadvantage to the use of aquatic herbicides is water use restrictions. These restrictions must be posted prior to treatment on a public body of water. The most common restriction is irrigation. Another disadvantage to the use of herbicides is the release of nutrients that can occur if large areas of vegetation are controlled. This can be avoided by early application that controls vegetation before it reaches its maximum biomass. These perceived disadvantages are often times out-weighed by this technique's proven rapid effectiveness and selectivity.

There are two different types of aquatic herbicides, systemic and contact. Systemic herbicides are translocated throughout the plants and thereby kill the entire plants. Fluridone (trade name Sonar & Avast!), 2,4-D (trade name Navigate, Aqua-Kleen, & DMA4 IVM), and triclopyr (trade name Renovate) are systemic herbicides that can effectively control Eurasian watermilfoil. Triclopyr, imazypry, and glyphosate are systemic herbicides that can control purple loosestrife.

Based upon the author's experience and personal communication with an array of North American aquatic plant managers, whole-lake fluridone applications are by far the most effective means of controlling Eurasian watermilfoil. Successful fluridone treatments yield a dramatic reduction in the abundance of Eurasian watermilfoil, often reducing it to the point that Eurasian watermilfoil plants are difficult to detect following treatment (Smith, 2002). An advantage to using fluridone over most contact herbicides is its selectivity. Most strains of Eurasian watermilfoil have a lower tolerance to fluridone than the majority of native species, so if the proper rates are applied Eurasian water milfoil can be controlled with limited harm to the majority of native species.

Aquatic Control has completed whole lake fluridone treatments on two public natural lakes in Indiana. Webster Lake was treated in 1999 and 2002. Re-infestation of Eurasian watermilfoil happened in three years, but that may have been due to milfoil presence in the immediate watershed. Wolf Lake, a 451-acre lake in northwest corner of Indiana, was treated with fluridone in 2004 and no Eurasian watermilfoil has been detected since the treatment. The long-term success of a fluridone treatment is variable from lake to lake. Since milfoil can spread by fragmentation, success of the treatment is dependent on eliminating all of the plants from the watershed.

Triclopyr is a systemic herbicide that has recently been approved for use in aquatics. Triclopyr typically is used for treating isolated milfoil beds as opposed to whole lake treatments. This herbicide is very selective to Eurasian watermilfoil. A study was conducted in 1997 during the registration process of this herbicide. The study found Eurasian watermilfoil biomass was reduced by 99% in treated areas at 4 weeks post-treatment, remained low one year later, and was still at acceptable levels of control at two years post-treatment. Non-target native plant biomass increased 500-1000% by one year post-treatment, and remained significantly higher in the cove plot at two years post-treatment. Native species diversity doubled following herbicide treatment, and the restoration of the community delayed the re-establishment and dominance of Eurasian watermilfoil for three growing seasons (Getsinger et. al., 1997). Triclopyr is a good alternative to fluridone when Eurasian watermilfoil is not abundant throughout an entire water body. It would likely be impossible to completely eliminate Eurasian watermilfoil with this type of herbicide, but an aggressive treatment program could significantly reduce milfoil density and abundance to a more manageable level. Eurasian watermilfoil must be treated everywhere it is located in the lake. The only water use restriction following a triclopyr treatment is irrigation. An assay is needed to monitor the concentration in the water before irrigation can take place. One of the drawbacks to using triclopyr has been the fact that only a liquid formulation has been available. This can dramatically increase costs for treatment in deep water areas. In 2007, a granular formulation called Renovate OTF was approved for aquatic use in Indiana.

Applied properly, 2,4-D can also yield major reductions in the abundance of Eurasian watermilfoil. Much like triclopyr, treatments must be even and dose rates accurate. This formulation should be used much like Triclopyr. Unlike Triclopyr, 2,4-D can impact the native species coontail. This herbicide can be applied for less cost than triclopyr, but damage will likely occur to coontail. 2,4-D herbicide should be considered as an alternative to triclopyr applications if the Association's budget is restricted. 2,4-D is also available in liquid and granular formulations.

Contact herbicides can also be effective for controlling submersed vegetation in the short term. The three primary contact herbicides used for control of submersed vegetation are diquat (trade name Reward), endothal (trade name Aquathol), and copper based formulations (trade names Komeen, Nautique, and Clearigate).

Historically, a drawback to the use of contact herbicides has been the lack of selectivity exhibited by these herbicides. However, a study completed by Skogerboe and Getsinger in 2002 outlines how endothal can be used for control of the exotic species curlyleaf pondweed and Eurasian watermilfoil with little effect on the majority of native species. They found early season treatments with endothall effectively controlled Eurasian watermilfoil and curlyleaf pondweed at several application rates with no regrowth eight weeks after treatment. Sago pondweed, eel grass, and Illinois pondweed biomass were also significantly reduced following the endothall application, but regrowth was observed at eight weeks post-treatment. Coontail and elodea showed no effects from endothall at three of the lower application rates. Spatterdock, pickerelweed, cattail, and smartweed were not injured at any of the application rates (Skogerboe & Getsinger 2002). This type of treatment strategy could be applied to lakes that have large areas of both curlyleaf pondweed and Eurasian watermilfoil. Endothal could also be effective the year after whole lake sonar treatments where curlyleaf pondweed typically returns the following season.

Diquat and many of the copper formulations are effective fast acting contact herbicides. These formulations are typically used when control of all submersed vegetation is desired. These herbicides are commonly used for control of nuisance vegetation around docks and near-shore high-use areas. Diquat and the copper based herbicides are not as selective as many of the other herbicides and plants can recover in 4-8 weeks after treatment. There are no water use restrictions following the use of chelated copper based herbicide, which makes them popular choices for lakes used for irrigation or drinking water.

10.0 PUBLIC INVOLVEMENT

An effective aquatic vegetation management plan must include input from lake users. A public meeting was conducted on September 12, 2007 at the Webster Lake Community Center. Approximately seventeen individuals attended the meeting.

The goals of the meeting were as follows:

1. Inform lake users of the planning process
2. Document important high-use areas of the lake
3. Educate those in attendance on aquatic plant ecology
4. Describe results of the plant sampling
5. Discuss plant management alternatives
6. Discuss implementation of the potential management strategies and monitoring programs
7. Obtain user input by filling out a survey

A lake use survey was handed out prior to the meeting. Thirteen individuals filled out the forms. The results of the survey are summarized in Table 5. According to the survey 100% were property owners and members of a lake association. The majority of those surveyed had lived on the lake for more than 10 years. Swimming and boating were the most popular activities (92%) followed closely by fishing (85%). On survey questions dealing with aquatic vegetation; 92% believed vegetation interfered with lake use, 92% believed they had nuisance quantities of vegetation, 92% believed it affected property value, and 100% were in favor of continuing vegetation control efforts. In addition it appears that the audience was fairly knowledgeable concerning LARE since 100% were aware LARE funds could only be used for control of invasive exotic species. On survey questions concerning lake problems; 100% believed dredging was needed, 85% thought there were too many aquatic plants, 54% believed water quality was a problem, 23% thought the use of jet skis was an issue, 15% checked fish population and pier funneling as a problem, 8% checked both too many boats with access and overuse by non residents as a problem. Nobody checked “not enough aquatic plants” as a problem with Ridinger Lake.

Table 5. Ridinger Lake, Lake User Survey, September 12, 2007.

Ridinger Lake User Survey 9/12/07		
Are you a lake property owner?	Yes: 100%	No: 0%
Are you currently a member of your lake association?	Yes: 100%	No: 0%
How many years have you been at the lake?	2 or Less: 8%	5 to 10: 23%
	2 to 5: 15%	Over 10: 54%
How do you use the lake (mark all that apply)	92% Swimming	0% Irrigation
	92% Boating	0% Drinking water
	85% Fishing	8% Other: viewing
Do you have aquatic plants at your shoreline in nuisance quantities?	Yes: 92% No: 8%	
Does aquatic vegetation interfere with your use or enjoyment of the lake?	Yes: 92% No: 8%	
Does the level of vegetation in the lake affect your property values?	Yes: 92% No: 0% No Response: 8%	
Are you in favor of continuing efforts to control vegetation on the lake?	Yes: 100% No: 0%	
Are you aware that the LARE funds will only apply to work controlling invasive exotic species, and more work may need to be privately funded?	Yes: 100% No: 0%	
Were you satisfied with the results of the LARE funded invasive treatments this season?	Yes: 77% No: 8% No Response: 15%	
Mark any of these you think are problems on your lake:		
8% Too many boats access the lake		
23% Use of jet skis on the lake		
0% Too much fishing		
15% Fish population problem		
100% Dredging needed		
8% Overuse by nonresidents		
85% Too many aquatic plants		
0% Not enough aquatic plants		
54% Poor water quality		
15% Pier/funneling problem		

11.0 PUBLIC EDUCATION

In order to effectively manage aquatic vegetation lake users must gain an understanding of the ecology of the lake ecosystem and the effects individual actions may have on this resource. The lake user survey made it apparent that the public has a different perception of Ridinger Lake's problems than many of the biologists which have worked on the lake. This is an important issue that will need to be addressed by educating lake users on the benefits of native vegetation. A positive that can be taken out of the survey is that it appears that those surveyed were up to date on the LARE program and also concerned with water quality which is definitely a major problem. Annual public meetings should be completed in order to keep lake users up to date on management activities. In addition, those living on the lake should be encouraged to attend educational seminars and conferences that are offered by the Indiana Lake Management Society. There are many things that individual can do to positively impact the quality of Ridinger Lake. A list of actions was recommended in the 2004 Diagnostic Study and is repeated below:

1. Reduce the frequency and amount of fertilizer, herbicide, or pesticide used for lawn care.
2. Use only phosphorus-free fertilizer.
3. Consider re-landscaping lawn edges, particularly those along the watershed's lakes, to include low profile prairie species that are capable of filtering runoff water better than turf grass
4. Consider resurfacing concrete or wooden seawalls with glacial stone, then planting native emergent vegetation along shorelines or in front of resurfaced or existing concrete or wooden seawalls to provide fish and invertebrate habitat and dampen wave energy.
5. Keep organic debris like lawn clipping, leaves, and animal waste out of the water
6. Examine all drains that lead from roads, driveways, and rooftops to the watershed
7. Obey speed limits through the lakes
8. Clean all plant fragments and sediment from boats, propellers, and trailers after lake use and refrain from dumping bait buckets into the lake to prevent the spread of exotic species (JFNew, 2004). Additional information on stopping the spread of exotic species can be found at www.protectyourwaters.net.

These points should be reinforced at annual meetings and in newsletters.
In addition to the individual recommendations, there are many specific recommendations that can have even greater impacts on Ridinger Lake. These recommendations are outlined on page 163, 164, and 165 of the 2004 Diagnostic study.

12.0 INTEGRATED MANAGEMENT ACTION STRATEGY

The focus of the action strategy should be designed to meet the goals and objectives of the aquatic plant management plan. To review, the goals are as follows:

1. Develop a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality, and is resistant to minor habitat disturbances and invasive species

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.
3. Provide reasonable public recreational access while minimizing the negative impacts on plant and fish and wildlife resources.

Each goal, along with objectives to meet this goal, is listed below. Following each objective are the actions which should be taken in order to achieve the objective.

12.1 Goal #1-Develop a Stable and Diverse Native Population

The first goal focuses on developing a stable, diverse aquatic plant community. In order to address the objectives for meeting this goal the plant community will be divided into two categories: rooted floating/emergent vegetation and submersed vegetation. The focus of the LARE program is primarily on control of nuisance exotic submersed vegetation, but seeing how this is an aquatic vegetation management plan one cannot ignore the wetland plant community.

Objective 1: Maintain and Enhance Diversity and abundance of the Rooted Floating/Emergent Aquatic Plant Community

There are three significant wetland areas in and around Ridinger Lake that contain the majority of emergent and rooted floating plants. These areas are located in the northwest, south, and southeast corners of the lake and are illustrated in Figure 3. This community serves several beneficial purposes to Ridinger Lake that includes reducing erosion, providing fish and wildlife food and habitat, and filtering excessive nutrients. These plant communities should be protected from development. Much of the eastern and western shorelines are developed for residential use. Some emergent vegetation is present along these shorelines. Throughout the remainder of the developed areas, residents have created beaches and installed a limited number of wooden and rock seawalls. Seawalls are somewhat effective at reducing erosion, but they also eliminate a very ecologically important area of the lakes ecosystem and increase wave action in the lake. New developments should consider natural shorelines that allow emergent and rooted floating vegetation to grow. A dense shallow water plant community should help reduce erosion, prevent geese from entering and exiting the lake, provide cover for fish and wildlife, and help filter nutrients that may enter the lake from developed sites. If erosion is still a problem, glacial stone is the recommended as a replacement for rip-rap or concrete. Figure 18 is an example of a developed shoreline on Crooked Lake in Steuben County. This home site has allowed native vegetation to flourish along their shoreline yet still has good lake access.

Figure 18. Crooked Lake, emergent plant community along developed shoreline, June 2006.

In previous surveys, purple loosestrife was found at low levels within the remaining emergent plant beds surrounding Ridinger Lake. This plant has the potential to spread and displace beneficial native species. To date the LARE program has not funded control of this plant, so it is important that residents take action in securing funds from other sources and conduct their own controls. Since it is present at low levels it may be possible for residents to control this plant. Residents should become familiar with this species and dig it up if it is found on their property. Figure 19 is a picture of purple loosestrife that may aid in identification.

Figure 19. Picture of purple loosestrife mixed with other emergent plants (provided by Applied Biochemist).

Objective 2: Enhance density and diversity of beneficial native submersed vegetation.
Due to poor water quality and low light penetration, Ridinger Lake has a relatively low density and diversity of submersed vegetation. Native submersed vegetation provides fish cover, filters nutrients, and is vital to the overall ecology of Ridinger Lake. Lake users need to be educated on the benefits of the remaining native vegetation and take steps to improve water quality so that density and diversity can increase. This can be accomplished by acting on the recommendations laid out in the Diagnostic study. In addition, native vegetation should only be controlled where it is obviously negatively impacting lake use. Residents should keep in mind that a few native plants around a dock area do not negatively impact lake use. Reduction in Eurasian watermilfoil should also reduce competition with native vegetation. Once the milfoil is controlled native plants should increase in abundance.

12.2 Goal #2-Reduce Negative Impacts Caused by Exotic Vegetation
The second goal of the vegetation management plan is to prevent and reduce negative impacts of aquatic invasive species. Goal one and two are somewhat related because one of the negative impacts of invasive species is their tendency to displace beneficial native vegetation.

Objective 1: Reduce and Control Eurasian watermilfoil density and abundance
One of the main invasive species of concern is Eurasian watermifilfoil. Eurasian watermilfoil reproduces through fragmentation and can rapidly reach nuisance levels. This makes it of special concern when it comes to aquatic plant management. This species can also displace native vegetation due to this rapid growth and its tendency to form a canopy shading out native species.

Whole lake fluridone treatments have historically been the best method for long-term control of Eurasian watermilfoil. This technique is not ideal for Ridinger Lake since there is an abundance of Eurasian watermilfoil in other lakes that are connected to Ridinger and milfoil only occupies a narrow shoreline band. The costs of a whole lake treatment would likely outweigh the benefits.

LARE funded treatment of 10.4 acres of milfoil in 2007. The treatment was completed with 2,4-D herbicide and resulted in no milfoil detection in the summer survey. Due to the success of this treatment, it is recommended that 2,4-D spot treatments be used in future milfoil control efforts. This action will be selective towards Eurasian watermilfoil and has the potential to provide long-term control. In order to effectively complete this treatment, areas containing Eurasian watermilfoil will have to be mapped out prior to treatment. All areas containing Eurasian watermilfoil should be treated in late spring, following creation of a treatment map. Areas should be treated with 100 pounds per acre of Navigate (granular 2,4-D). Due to the limited history of treatments on this lake along with the limited amount of survey data, it is difficult to determine how much milfoil will return. Last season, over 14 acres of milfoil was mapped out, but funds were only available to treat 10.4 acres. In order to insure enough funds are available for next season, it is recommended that the Association request $4,550 for treatment of 14 acres. The actual treatment areas will be determined following the invasive species survey. Treatments may need to be repeated the following season due to the difficulty in finding and controlling all milfoil plants and due the presence of this species in other connected lakes. However, the abundance of this species should be significantly reduced in following years. Non-turf irrigation will be the primary water-use restriction following treatment. Typically, after 14 days, 2,4-D levels are low enough to irrigate. There is also a 1-day swimming restriction associated with this treatment.

Along with chemical control, it will be important for lake users to do their part in controlling Eurasian watermilfoil. Eurasian watermilfoil spreads through fragmentation, so it is easy to introduce this species to new areas. It is important that boaters avoid driving through any milfoil beds. This can chop up the plants causing them to float into new areas. It is also important that boaters check their props and trailers when traveling from lake to lake removing any plant fragments. One fragment of milfoil can lead to an entire colony. Signs should also be placed at all access points warning boaters to check for plant fragments. This is especially important since the discovery of hydrilla (*Hydrilla verticillata)* in Lake Manitou.

Objective 2: Prevent further spread of Purple Loosestrife

As mentioned when discussing goal number one, purple loosestrife can be detrimental to native wetland species. No purple loosestrife was detected in this years sampling, but it was noted in a 2003 survey. If this species is discovered on one's property, it will be important to individual homeowners to dig up and remove the entire plant. A picture of this species was included in Figure 19 located on the previous page of this plan.

Objective 3: Monitor curlyleaf pondweed and control if necessary
The exotic species, curlyleaf pondweed is common to northern Indiana lakes, and was found at low levels during surveys of Ridinger Lake. This species should be monitored for the next several years in order to assess the need for control.

Objective 4: *Create public awareness of the potential for hydrilla invasion and post signs for cleaning off boats at all private and public access sites*
Hydrilla, an extremely aggressive submersed aquatic plant species, has been recently discovered in Lake Manitou, which is located in north central, Indiana. Currently, it is believed that this plant is isolated in the Lake Manitou area, but much like Eurasian watermilfoil, this species has the ability to reproduce by fragmentation. This allows it to be spread easily from lake to lake. It is very important that lake users understand the importance of thoroughly cleaning off their boats when entering and exiting Ridinger Lake. Posting signs at the ramp will help reinforce this point. Warnings about this plant should also be sent to members of the Association. The best way to distinguish hydrilla from native elodea is that hydrilla typically has five leaves along each whorl along with visible serrated edges along the leaf margin (Figure 20). More information about controlling the spread of hydrilla can be found at www.protectyourwaters.net.

Figure 20. Illustration of hydrilla on the left compared to native elodea on the right. Hydrilla typically contains five toothed leaves per whorl while native elodea typically has three leaves per whorl and the teeth are not visible on the leaves (Illustrations provided by Applied Biochemist).

12.3 Goal #3: Provide Reasonable Recreational Access While Minimizing the Negative Impacts on Plant, Fish, and Wildlife Resources
The focus of plant control should be on nuisance exotic species, but even if all exotic species were eliminated it may be necessary to control some native plants in order to provide access to docks and high-use areas.

Objective 1: Control vegetation around docks and the boat ramp in order to allow for boat access
If left unchecked, some homeowners may be negatively impacted by native vegetation. Some homeowners may have the ability to physically remove the vegetation from these areas (625 square feet can be removed without a permit). It is recommended that if possible, and if needed, homeowners control only 625 square feet. However, some areas may be too dense or some homeowners may not be capable of completing this task. In this case it will be necessary to contact professionals to complete the work. Applied properly, aquatic herbicides are typically the best method for control of dense vegetation growth. Treatment should be limited to near shore high-use areas. Width of shoreline treatments should not exceed 100 feet out from shore. Treatment of rooted floating vegetation should be limited to a wide enough area for boats to pass (20-30 feet). It has also been IDNR's policy to only permit treatment of native vegetation in half of the shoreline areas of any given lake.

12.4 List of Actions To Be Initiated
The purpose of the LARE grant was to fund aquatic vegetation control on public lakes. Listed below, in order of importance, are recommended actions in order to meet the goals and objectives of the aquatic vegetation management plan. Some of these actions may be funded by LARE, but many will require funds from the Association.

1. Continue treatment of Eurasian watermilfoil in Ridinger Lake with 2,4-D herbicide. Treatment should take place in the spring of 2008 following sampling that will determine actual treatment areas. Treatment may be needed the following seasons and should be included in the long-term budget.

2. Monitor plant community with plant surveys for next five years in order to assess the effectiveness of controls and response of native plant community. Plant surveys will also be invaluable to quickly detect and control potential reinfestation of Eurasian watermilfoil. Surveys should consist of a spring invasive mapping survey and a summer Tier II survey. These surveys should be continued through 2012.

3. Post signs at access sites warning boaters of the potential for invasive plant species introductions from boat trailers. Signs should implore boaters to clean trailers, props, and boats of all vegetation fragments when entering and leaving Ridinger Lake. Information concerning the potential spread of Eurasian watermilfoil and hydrilla should be distributed to all Association members and lake users.

4. Take steps to improve water quality in Ridinger Lake. These potential actions are outlined in the 2004 Diagnostic Study. The Ridinger Lake Property Owners Association along with TELWF should work with IDNR on potential ways of funding these actions. These actions should have positive effects on the native plant community.

5. Remove purple loosestrife from individuals' property and pursue funding source to biological controls.

6. Maintain dock areas with physical plant removal when possible or by contracting professional applicators. Treatments should not exceed 100 feet from shoreline for submersed vegetation and treatment of rooted floating vegetation should be limited to boating lanes.

7. Monitor curlyleaf pondweed population with spring invasive species mapping surveys.

13.0 PROJECT BUDGET

Table 6 is an estimated budget for the aquatic vegetation management action plan. The most difficult part of making this budget is predicting the amount of milfoil that will return. Plant sampling will be one of the most important actions in order to monitor the effects of the control techniques. Sampling should consist of a spring invasive mapping survey to map treatment areas along with a Tier II survey in the summer. It is proposed that IDNR fund treatment of milfoil and plant survey updates (this will require a 10% match from the Association). **It is our recommendation that the Ridinger Lake Property Owners Association requests $4,550 for treatment of Eurasian watermilfoil in 2008. The Association should also request $5,000 plant sampling and plan updates.** A permit has been created for the milfoil treatment and is included in the Appendix. This permit should be handled by the association and once a contractor is selected for the treatment the permit can be completed.

Table 6. Budget estimate for action plan

	2008	2009	2010	2011	2012
Selective treatment of Eurasian watermilfoil with 2,4-D herbicide	$4,550	$4,000	$3,000	$2,000	$1,000
Plant sampling and plan updates (potential LARE funding with 10% match)	$5,000	$5,000	$5,000	$5,000	$5,000
Total:	**$9,550**	**$9,000**	**$8,000**	**$7,000**	**$6,000**

*Request $9,550 from LARE program in 2007.

14.0 MONITORING AND PLAN UPDATE PROCEDURES

One of the most important actions in the aquatic vegetation management plan is the continued monitoring of the plant population. Continued monitoring will provide valuable data to the aquatic plant manager. This data can be used to complete the following tasks: allow for needed changes to be made to the plan; monitor success or failure of controls; monitor improvements or damage to native plants; and detect potential new invasive species at an early stage of infestation. In 2008, monitoring should consist of a treatment map survey in the spring along with a Tier II survey in July or August. The Tier II survey provides managers with quantitative data that can point out trends in the plant community. Each winter this data should be analyzed and included in an update to the aquatic vegetation management plan. The surveys may lead to changes in the recommended actions of the plan.

15.0 REFERENCES CITED

Applied Biochemists. 1998. Water weeds and algae, 5th edition. Applied Biochemists, J. C. Schmidt and J. R. Kannenberg, editors. Milwaukee, Wisconsin.

Bachmann, R.W., Horsburgh, C.A., Hoyer, M.V., Mataraza, L.K., and D.E. Canfield. 2002. Relations between trophic state indicators and plant biomass in Florida lakes. Department of Fisheries and Aquatic Sciences, University of Florida. Hydrobiologia 470:219-234.

Bright Spot Maps. 1999. Indiana, 51 Lake Maps Featuring Contours and Depths. LaPorte, Indiana.

Chadde, S. W. 1998. A Great Lakes Wetland Flora. Pockteflora Press, Calumet Michigan.

DiTomaso, J. M., and E.A. Healy. 2003. Aquatic and Riparian Weeds of the West. University of California Agriculture and Natural Resources. Oakland, CA.

Fassett, N. C. 1968. A Manual of Aquatic Plants. The University of Wisconsin Press. Madison, WI.

Getsinger, K.D., Turner, E.G., Madsen, J.D., and M.D. Netherland. 1997. Restoring Native Vegetation in a Eurasian Water Milfoil-Dominated Plant Community Using The Herbicide Triclopyr. Regulated Rivers: Research & Management, Vol. 13, 357-375.

Hoyer, M.V. and D.E. Canfield, Jr., eds. 1997. Aquatic Plant Management in Lakes and Reservoirs. Prepared by the North American Lake Management Society and the Aquatic Plant Management Society for U.S. Environmental Protection Agency, Washington, D.C.

IDNR. 2007. Procedure Manual For Surveying Aquatic Vegetation: Tier I Reconnaissance Surveys. IN Department of Natural Resources, Division of Fish Wildlife

IDNR. 2007. Procedure Manual For Surveying Aquatic Vegetation: Tier II Reconnaissance Surveys. IN Department of Natural Resources, Division of Fish and Wildlife

JFNew and Associates. 2004. Ridinger Lake Watershed Diagnostic Study. Prepared for the Barbee Lakes Property Owners Association. Walkerton, Indiana.

Maceina, M.J., Reeves, W.C., Wrenn, W.B., and D.R. Lowery. 1996. Relationships Between Largemouth Bass and Aquatic Plants in Guntersville Reservoir, Alabama. American Fisheries Society Symposium 16:382-395.

Madsen, J.D., Sutherland, J.W., Bloomfield, J.A., Eichler, L.W., and C.W. Boylen, 1988. The decline of native vegetation under dense Eurasian watermilfoil canopies. Journal of Aquatic Plant Management., 29, 94-99.

North American Lake Management Society and the Aquatic Plant Management Society. 1997. Aquatic Plant Management in Lakes and Reservoirs. U.S. Environmental Protection Agency, Office of Water Assessment and Watershed Protection Division, Washington, DC.

Pearson, J. 2004. A Sampling Method to Assess Occurrence, Abundance and Distribution of Submersed Aquatic Plants in Indiana Lakes. IN Department of Natural Resources. Division of Fish & Wildlife, Indianapolis, Indiana.

Scribalio, R.W., and M.S. Alix. 2003. Final Report on the Weevil Release Study for Indiana Lakes. Department of Botany and Plant Pathology. Purdue University. West Lafayette, IN.

Skogerboe, J.G., and K.D. Getsinger. 2002. Endothall species selectivity evaluation: northern latitude aquatic plant community. J. Aquatic Plant Management. 40: 1-5.

Smith, C.S. 2002. Houghton Lake Management Feasibility Study. Prepared for the Houghton Lake Improvement Board. Remetrix LLC. Indianapolis, IN.

Thompson, Daniel Q., Ronald L. Stuckey, Edith B. Thompson. 1987. Spread, Impact, and Control of Purple Loosestrife (Lythrum salicaria) in North American Wetlands. U.S. Fish and Wildlife Service. 55 pages.

Winterringer, G. S. and A.C. Lopinot. 1977. Aquatic Plants of Illinois. Department of Registration & Education, Illinois State Museum Division & Department of Conservation, Division of Fisheries. Springfield, IL.

16.0 APPENDICIES

16.1 Data Sheets

Lake	Date	Latitude	Longitude	Design	Site	Depth	RAKE	Eurasian watermilfoil (*Myriophyllum spicatum*) MYSP2	curlyleaf pondweed (*Potamogeton crispus*) POCR3	common coontail (*Ceratophyllum demersum*) CEDE4	Chara (Chara spp.) CH?AR	Slender naiad (*Najas flexilis*) NAFL	sago pondweed (*Potamogeton pectinatus*) POPE6	leafy pondweed (*Potamogeton foliosus*) POFO3	water stargrass (*Zosterella dubia*) ZODU
Ridinger	5/30/07	41.262812	-85.669238		1	2.0	5			3	1	3			
Ridinger	5/30/07	41.262033	-85.669251		2	10.0									
Ridinger	5/30/07	41.261638	-85.669575		3	3.0	1	1		1		1			
Ridinger	5/30/07	41.261169	-85.66967		4	5.0	1			1		1		1	
Ridinger	5/30/07	41.260657	-85.669836		5	7.0									
Ridinger	5/30/07	41.260152	-85.669994		6	3.0	5				3	3			
Ridinger	5/30/07	41.259557	-85.670035		7	5.0	3			3					
Ridinger	5/30/07	41.258809	-85.669797		8	5.0	1			1					
Ridinger	5/30/07	41.258033	-85.669275		9	4.0	1			1		1			
Ridinger	5/30/07	41.257217	-85.669105		10	5.0	1			1					
Ridinger	5/30/07	41.256876	-85.670124		11	7.0									
Ridinger	5/30/07	41.256061	-85.670348		12	8.0	1			1					
Ridinger	5/30/07	41.25557	-85.668951		13	3.0	3	1		3		1		1	
Ridinger	5/30/07	41.255527	-85.667867		14	2.0	5	1		1	3	1	1		
Ridinger	5/30/07	41.255235	-85.666665		15	2.0	5	1		3		1	3		1
Ridinger	5/30/07	41.255683	-85.665607		16	9.0									
Ridinger	5/30/07	41.256488	-85.664428		17	5.0									
Ridinger	5/30/07	41.257092	-85.663727		18	7.0									
Ridinger	5/30/07	41.257548	-85.663262		19	3.0	1	1		1					
Ridinger	5/30/07	41.257874	-85.663905		20	4.0	5	1		5					
Ridinger	5/30/07	41.258226	-85.664627		21	3.0	5	3		3			3		
Ridinger	5/30/07	41.2588	-85.665095		22	6.0	1					1			
Ridinger	5/30/07	41.259552	-85.665382		23	5.0	1	1		1					
Ridinger	5/30/07	41.260315	-85.66539		24	7.0	1	1							
Ridinger	5/30/07	41.260812	-85.66488		25	3.0	1		1	1		1			
Ridinger	5/30/07	41.26126	-85.66431		26	3.0	5	1	1	5					
Ridinger	5/30/07	41.261896	-85.663703		27	2.0	1	1		1					
Ridinger	5/30/07	41.262505	-85.663333		28	4.0	3	1		3					
Ridinger	5/30/07	41.262999	-85.663156		29	3.0	3			3		1			
Ridinger	5/30/07	41.263308	-85.663359		30	3.0	1	1			1	1			
Ridinger	5/30/07	41.263789	-85.663477		31	7.0									
Ridinger	5/30/07	41.264404	-85.663309		32	4.0	3			3	1	1			
Ridinger	5/30/07	41.265064	-85.663515		33	2.0	3	1					3		
Ridinger	5/30/07	41.265476	-85.664059		34	2.0	3	1				1	1		
Ridinger	5/30/07	41.265838	-85.664867		35	2.0	3	1		3		1			
Ridinger	5/30/07	41.266125	-85.665598		36	3.0	3			3			1		
Ridinger	5/30/07	41.265999	-85.66617		37	3.0	3	1		3			1		
Ridinger	5/30/07	41.265919	-85.666582		38	2.0	3			3	1		1		
Ridinger	5/30/07	41.265418	-85.666797		39	6.0	3	3							
Ridinger	5/30/07	41.264951	-85.667268		40	5.0									
Ridinger	5/30/07	41.264539	-85.667295		41	5.0									
Ridinger	5/30/07	41.264035	-85.667378		42	5.0	3		1	3					
Ridinger	5/30/07	41.263851	-85.667718		43	2.0	1						1		
Ridinger	5/30/07	41.263512	-85.667762		44	4.0	1	1		1			1		
Ridinger	5/30/07	41.263367	-85.668168		45	2.0	5	5		1				1	
Ridinger	5/30/07	41.263124	-85.668455		46	5.0	3	1		1		1			
Ridinger	5/30/07	41.262937	-85.668985		47	2.0	3	1	3			1	1		
Ridinger	5/30/07	41.262494	-85.66918		48	5.0	3	1		3		1			
Ridinger	5/30/07	41.262002	-85.669638		49	2.0	5			5	1				
Ridinger	5/30/07	41.261493	-85.669734		50	1.0	1			1	1				

Lake	Date	Latitude	Longitude	Design	Site	Depth	RAKE	curlyleaf pondweed (*Potamogeton crispus*) POCR3	common coontail (*Ceratophyllum demersum*) CEDE4	Chara (Chara spp.) CH?AR	Slender naiad (*Najas flexilis*) NAFL	sago pondweed (*Potamogeton pectinatus*) POPE6	leafy pondweed (*Potamogeton foliosus*) POFO3	American pondweed (*Potamogeton nodosus*) PONO2
ridinger	7.24.07	41.262812	-85.669238		1	4.0	5		1	1	5			
ridinger	7.24.07	41.262033	-85.669251		2	11.0	0							
ridinger	7.24.07	41.261638	-85.669575		3	5.0	1				1			
ridinger	7.24.07	41.261169	-85.66967		4	6.0	1				1			
ridinger	7.24.07	41.260657	-85.669836		5	8.0	0							
ridinger	7.24.07	41.260152	-85.669994		6	6.0	1			1	1			
ridinger	7.24.07	41.259557	-85.670035		7	6.0	0							
ridinger	7.24.07	41.258809	-85.669797		8	6.0	0							
ridinger	7.24.07	41.258033	-85.669275		9	6.0	0							
ridinger	7.24.07	41.257217	-85.669105		10	9.0	0							
ridinger	7.24.07	41.256876	-85.670124		11	8.0	0							
ridinger	7.24.07	41.256061	-85.670348		12	8.0	1		1					
ridinger	7.24.07	41.25557	-85.668951		13	4.0	3		1		3			
ridinger	7.24.07	41.255527	-85.667867		14	2.0	5			3	5			1
ridinger	7.24.07	41.255235	-85.666665		15	4.0	1		1				1	
ridinger	7.24.07	41.255683	-85.665607		16	12.0	0							
ridinger	7.24.07	41.256488	-85.664428		17	9.0	0							
ridinger	7.24.07	41.257092	-85.663727		18	8.0	0							
ridinger	7.24.07	41.257548	-85.663262		19	10.0	0							
ridinger	7.24.07	41.257874	-85.663905		20	6.0	0							
ridinger	7.24.07	41.258226	-85.664627		21	3.0	3					1	3	
ridinger	7.24.07	41.2588	-85.665095		22	8.0	0							
ridinger	7.24.07	41.259552	-85.665382		23	8.0	0							
ridinger	7.24.07	41.260315	-85.66539		24	10.0	0		5		1			
ridinger	7.24.07	41.260812	-85.66488		25	7.0	0		1	1	5			
ridinger	7.24.07	41.26126	-85.66431		26	3.0	5							
ridinger	7.24.07	41.261896	-85.663703		27	2.0	5		1	1			1	
ridinger	7.24.07	41.262505	-85.663333		28	7.0	0							
ridinger	7.24.07	41.262999	-85.663156		29	4.0	3							
ridinger	7.24.07	41.263308	-85.663359		30	6.0	0							
ridinger	7.24.07	41.263789	-85.663477		31	10.0	0							
ridinger	7.24.07	41.264404	-85.663309		32	6.0	1						1	
ridinger	7.24.07	41.265064	-85.663515		33	4.0	5			1	5			
ridinger	7.24.07	41.265476	-85.664059		34	2.0	5			1	5			
ridinger	7.24.07	41.265838	-85.664867		35	2.0	1		1					
ridinger	7.24.07	41.266125	-85.665598		36	4.0	5		5				1	
ridinger	7.24.07	41.265999	-85.66617		37	3.0	3		1		3			
ridinger	7.24.07	41.265919	-85.666582		38	2.0	3		1			3		
ridinger	7.24.07	41.265418	-85.666797		39	7.0	0							
ridinger	7.24.07	41.264951	-85.667268		40	7.0	0							
ridinger	7.24.07	41.264539	-85.667295		41	7.0	0							
ridinger	7.24.07	41.264035	-85.667378		42	8.0	0							
ridinger	7.24.07	41.263851	-85.667718		43	1.0	1		1	1				
ridinger	7.24.07	41.263512	-85.667762		44	6.0	0							
ridinger	7.24.07	41.263367	-85.668168		45	4.0	5		1		5		1	
ridinger	7.24.07	41.263124	-85.668455		46	7.0	1						1	
ridinger	7.24.07	41.262937	-85.668985		47	3.0	5	1	5		3			
ridinger	7.24.07	41.262494	-85.66918		48	8.0	0							
ridinger	7.24.07	41.262002	-85.669638		49	2.0	5			1	5			
ridinger	7.24.07	41.261493	-85.669734		50	1.0	0							

16.2 IDNR VEGETATION PERMIT

			Return to: Page 1 of 2
	APPLICATION FOR AQUATIC VEGETATION CONTROL PERMIT	**FOR OFFICE USE ONLY**	DEPARTMENT OF NATURAL RESOURCES
	State Form 26727 (R / 11-03)	License No.	Division of Fish and Wildlife
	Approved State Board of Accounts 1987		Commercial License Clerk
	[ ] Whole Lake [x] Multiple Treatment Areas	Date Issued	402 West Washington Street, Room W273
	Check type of permit		Indianapolis, IN 46204
INSTRUCTIONS: Please print or type information		Lake County	FEE: $5.00

Applicant's Name: Jill Jordan	Lake Assoc. Name: Ridinger Lake Property Owners Assocition	
Rural Route or Street: 423 EMS R4 Lane		Phone Number: 574-834-2185
City and State: Pierceton		ZIP Code: 46562
Certified Applicator (if applicable)	Company or Inc. Name	Certification Number
Rural Route or Street		Phone Number
City and State		ZIP Code

Lake (One application per lake): Ridinger Lake	Nearest Town: North Webster	County: Kosciusko
Does water flow into a water supply		[ ] Yes [x] No

Please complete one section for *EACH* treatment area. Attach lake map showing treatment area and denote location of any water supply intake.

Treatment Area #	1	LAT/LONG or UTM's	Treat max of 14 acres of milfoil, areas to be determined following survey		
Total acres to be controlled	14	Proposed shoreline treatment length (ft)		Perpendicular distance from shoreline (ft)	<200
Maximum Depth of Treatment (ft)	8	Expected date(s) of treatment(s)	late may/early June		
Treatment method:	[X] Chemical	[ ] Physical	[ ] Biological Control	[ ] Mechanical	

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. 2,4-D granular for milfoil control

Plant survey method: [x] Rake [ ] Visual [ ] Other (specify) Based on Spring 2007 T2 Data

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Common coontail		35
Eurasian watermilfoil	x	20
Slender naiad		15
Sago pondweed		15
Chara		10
Curlyleaf pondweed		3
Leafy pondweed		2
Water stargrass		1

AQUATIC CONTROL

Treatment Area #		LAT/LONG or UTM's			
Total acres to be controlled		Proposed shoreline treatment length (ft)		Perpendicular distance from shoreline (ft)	
Maximum Depth of Treatment (ft)		Expected date(s) of treatment(s)			

Treatment method: ☐ Chemical ☐ Physical ☐ Biological Control ☐ Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control.

Plant survey method: ☐ Rake ☐ Visual ☐ Other (specify)

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community

INSTRUCTIONS: Whoever treats the lake fills in "Applicant's Signature" unless they are a professional. If they are a professional company who specializes in lake treatment, they should sign on the "Certified Applicant" line.

Applicant Signature	Date
Certified Applicant's Signature	Date

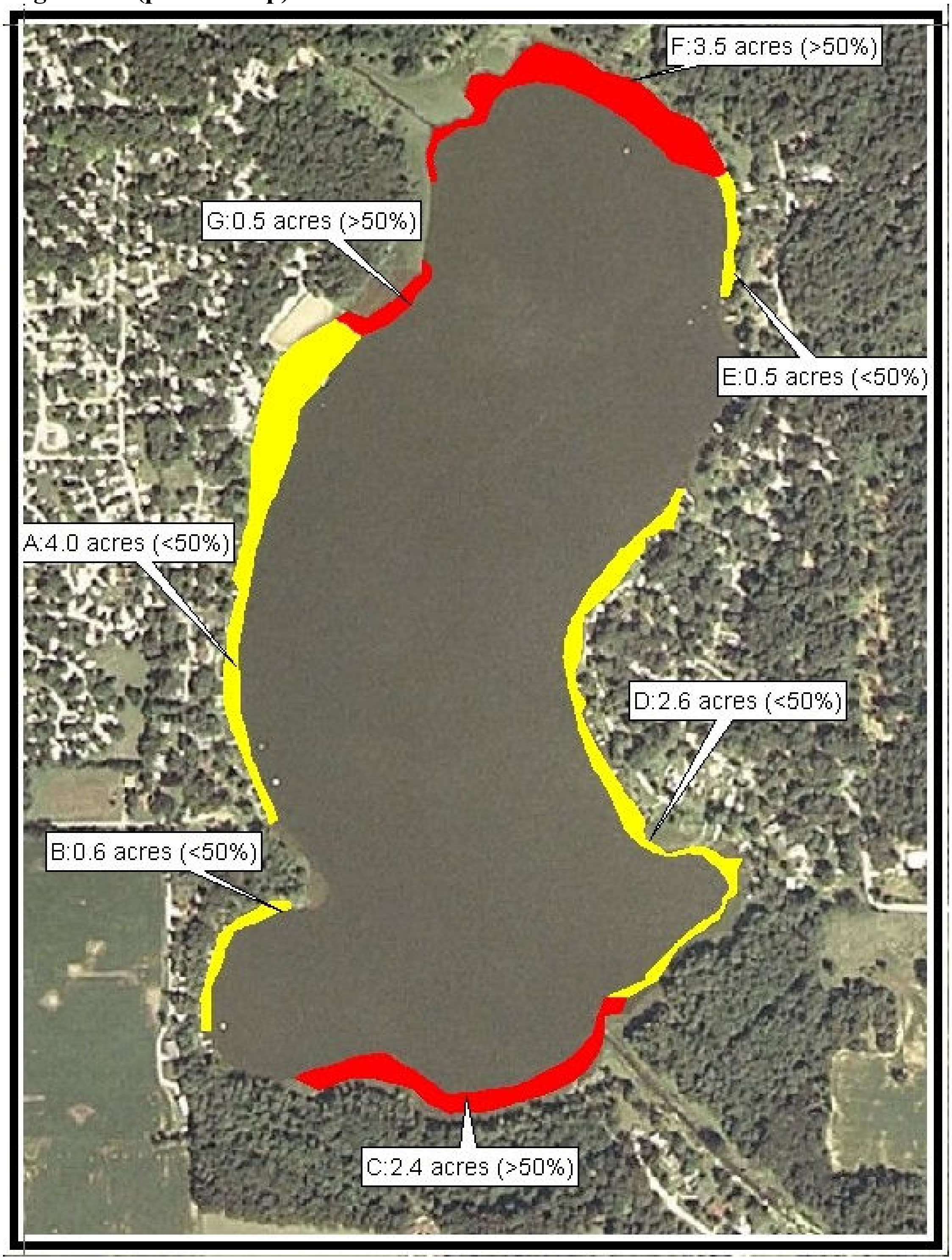
FOR OFFICE ONLY

☐ Approved ☐ Disapproved	Fisheries Staff Specialist
☐ Approved ☐ Disapproved	Environmental Staff Specialist

Mail check or money order in the amount of $5.00 to:

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
COMMERCIAL LICENSE CLERK
402 WEST WASHINGTON STREET ROOM W273
INDIANAPOLIS, IN 46204

Page 3 of 3 (permit map)



16.3 PUBLIC INPUT QUESTIONARE

Lake Use Survey Lake name____________________________

Are you a lake property owner? Yes________ No_________

Are you currently a member of your lake association? Yes ___ No___

How many years have you been at the lake?
2 or less
2 – 5 years
5-10 years
Over 10 years

How do you use the lake (mark all that apply)

___Swimming ___Irrigation
___Boating ___Drinking water
___Fishing ___Other ________________________

Do you have aquatic plants at your shoreline in nuisance quantities? Yes ___ No ___

Do you currently participate in a weed control project on the lake? Yes ___ No ___

Does aquatic vegetation interfere with your use or enjoyment of the lake? Yes ___ No___
Does the level of vegetation in the lake affect your property values? Yes ___ No ___

Are you in favor of continuing efforts to control vegetation on the lake? Yes ___ No ___

Are you aware that the LARE funds will only apply to work controlling invasive exotic species, and more work may need to be privately funded? Yes ___ No ___

Mark any of these you think are problems on your lake:

___ Too many boats access the lake
___ Use of jet skis on the lake
___ Too much fishing
___ Fish population problem
___ Dredging needed
___ Overuse by nonresidents
___ Too many aquatic plants
___ Not enough aquatic plants
___ Poor water quality
___ Pier/funneling problem

Please add any comments:

____

____

16.4 RESOURCES FOR AQUATIC VEGETATION MANAGEMENT

Books
Aquatic Plant Management in Lakes and Reservoirs
Aquatic Plants of Illinois
A Manual of Aquatic Plants
Managing Lakes and Reservoirs
Interactions Between Fish and Aquatic Macrophytes in Inland Waters
Lake and Reservoir Restoration

Societies/Websites
Aquatic Plant Management Society-apms.org
Midwest Aquatic Plant Management Society-mapms.org
North American Lake Management Society-nalms.org
Inidiana Lake Management Society-indianalakes.org